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POLLUTION PREVENTION PLANNING

GUIDANCE DOCUMENT
AND WORKBOOK



*Training manual for
discussion purposes
March 1993*



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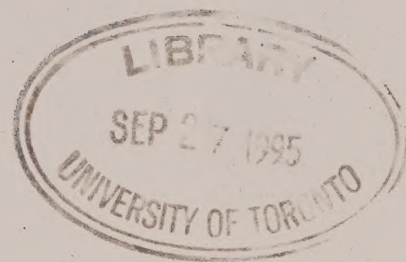
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**POLLUTION PREVENTION PLANNING
GUIDANCE DOCUMENT
AND WORKBOOK**

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PREFACE

WHO IS THIS MANUAL FOR ?

The response to the question is in two parts: the purpose of the document and who could most benefit from considering its contents.

PURPOSE

This guidance document and the companion workbook/ worksheets have been developed for three reasons:

- to provide an introduction to the concepts and principles of pollution prevention planning and its implementation;
- to offer a model or approach to initiating (or re-orienting) a pollution prevention team planning exercise within an organization (ie. organization includes most sizes of business from small, autonomous offices to large industrial sites, companies, corporations and institutions); and
- to provide a series of easy to follow worksheets and checklists that would help guide the planning process from assessments through prioritization and on to implementation.

WHO IS IT FOR ?

The intended audience includes managers, supervisors and empowered employees whose duties and responsibilities or personal interests include environmental and/or waste management activities. The size of the organization within which you work is not a limitation to the usefulness of this document. It offers practical insights, guidance and suggestions that can improve, or at least initiate discussions on, your approach to environmental management.

This document will be of most use to those organizations and individuals who are interested in or rely on a total quality management approach. The pollution prevention, planning concepts, information and guidance are presented simply with few diversions. While links have been identified to other complimentary subjects, not all subjects are treated in detail, the reader is referred to the selected bibliography.

The information contained in this guidance manual and tutorial guide are provided as general information regarding the development and implementation of a pollution prevention planning activity for an industrial, commercial or institutional business.

Any reference to trade names, trademarks, or commercial products are for the purpose of example or comparison only, and do not represent endorsement or approval of the crown in right of the Ministry of Environment and Energy (MOEE).

This Guidance document in no way releases or replaces the need for a facility to notify the MOEE of all changes to their activities involving a Certificate of Approval, Control Order, regulation or other MOEE instrument.

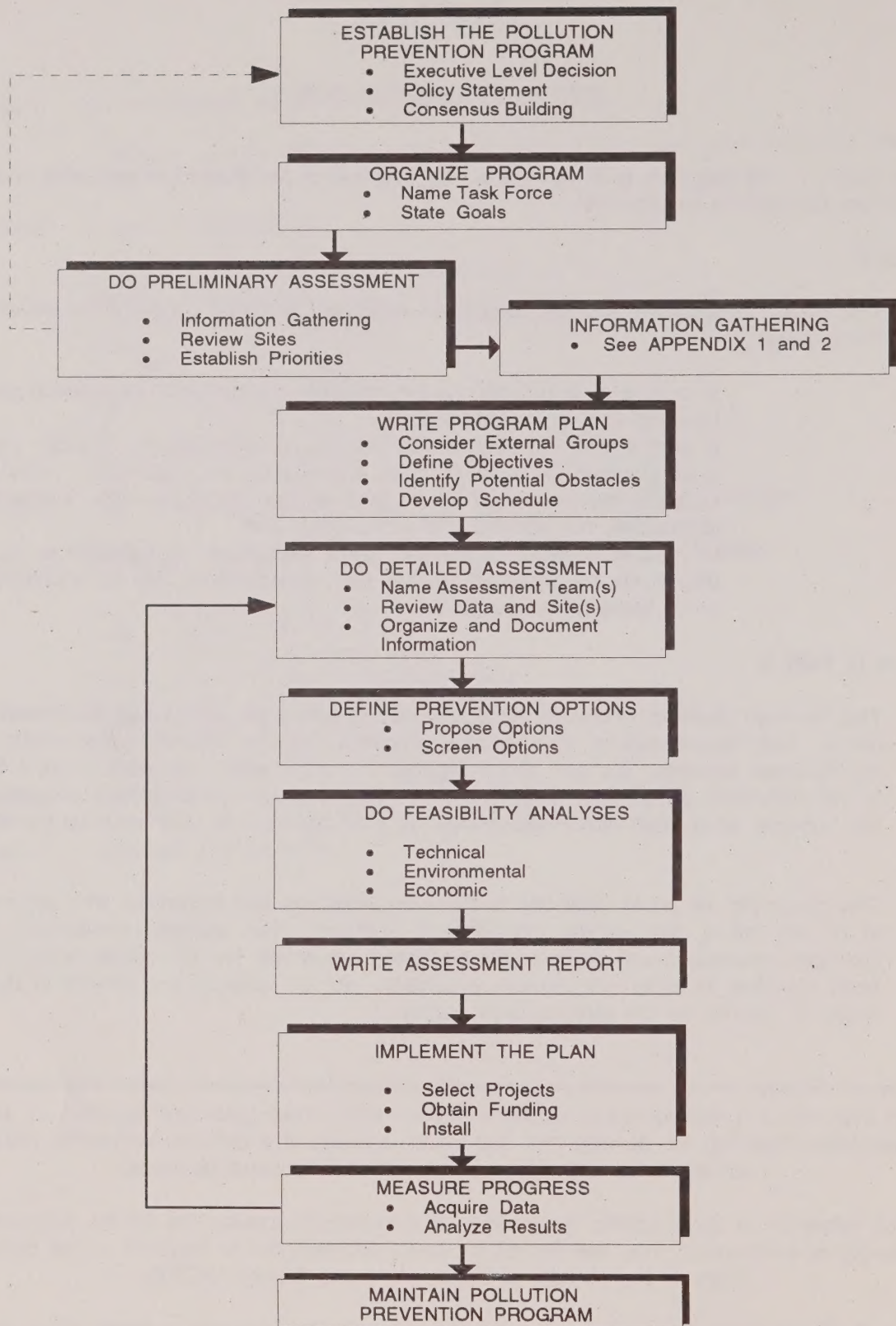


FIGURE A.
Pollution Prevention Planning Overview

EXECUTIVE SUMMARY

The traditional "command and control" approach to environmental management, which focuses on treatment rather than prevention of discharges to the environment will no longer meet the needs of either the regulating authorities or the companies and facilities seeking continued improvement in environmental quality.

The Pollution Prevention approach represents a significant advancement in environmental management. It offers both the regulating authority and respective industrial, commercial, institutional and private facility the opportunity to jointly work towards improving environmental conditions, reduce operating costs, reduce risk and resulting liability costs and result in significant progress in protecting and preserving the ecosystem which we all share.

Total Quality Environmental Management (TQEM) founded in the principles and function of a Total Quality Management system place a greater emphasis on pollution prevention at the sources as well as better resource management and conservation. The ultimate goal of Pollution Prevention is the elimination of pollution at the source. This will be achieved by first reviewing current practices; second, identifying sources of waste and pollution and finally, selecting and implementing new and innovative ways of progressively eliminating pollution. Prevention is achievable, but will require commitment, cooperation, innovation, ingenuity and diligent hard work.

This Pollution Prevention Planning Guide provides an approach based on: a total quality organizational framework; an integrated, multi-media assessment of pollution impacts; conceptual models, procedures and protocols that force attention to the front-end of industrial processes and all waste management systems; progressive reduction and elimination of pollution and waste prior to its creation; conservation and energy efficiency. The Guidance Document outlines a step-by-step approach to the initiation and development of a comprehensive, multi-media pollution prevention planning program (FIGURE A.) including guidance on:

- how to establish the program through top level commitment and consensus building;
- how to organize the program through an empowered management and employee team;
- the critical steps and areas to obtain information for a preliminary assessment of fast wins and potential for long term success;
- how to write a comprehensive program plan with objectives, stakeholder involvement and schedule for action;
- the steps involved with a detailed assessment and on-site walk-through to identify all waste produced;
- defining prevention options and feasibility analyses tailor made to suit your business;
- tips for writing the final assessment report; selecting and implementing prevention projects; measuring success; and
- how to maintain momentum for continuous improvement.

It is recognized that this Guidance Document is complete only when it has been reviewed and customized to the needs of each individual facility or organization. As such, it is offered as a starting point for discussion and action.

ACKNOWLEDGEMENTS

The contents of this guidance document and tutorial manual were taken in part from several publications including:

United States Environmental Protection Agency
Pollution Prevention Planning Guide EPA/600/R-92/088

Coopers & Lybrand Deloitte
Your Business and the Environment, A D-I-Y review for Companies

Canadian Standards Association
Environmental Management System Development Document Discussion Paper,
September 8th, 1992, Appendix A.

Ontario Waste Management Corporation
Hazardous Waste Audit and Reduction Manual, ISBN # 0-7729-5851-3 (2nd edition
July 1989)

In addition, this document would not have been possible without the considerable talents, knowledge, commitment and efforts of numerous staff from many divisions and offices of the Ministry of Environment and the Ministries of: Energy, Natural Resources, and Industry Trade and Technology.

INTRODUCTION

DEFINITION OF POLLUTION PREVENTION

The Ministry of Environment and Energy has defined pollution prevention as:

Any action which reduces or eliminates the creation of pollutants or wastes at the source, achieved through activities which promote, encourage or require changes in the basic behavioral patterns of industrial, commercial, institutional, community and government generators or individuals.

Pollution prevention includes practices that eliminate or reduce the use of hazardous and nonhazardous materials, energy, water, or other resources as well as those that protect natural resources through conservation or more efficient use.

An **industrial** pollution prevention program addresses all types of waste and represents an ongoing, comprehensive examination of the operations at a facility with the goal of minimizing all types of waste products. An effective prevention program will:

- protect employee & public health and the environment;
- improve employee morale and participation;
- reduce operating costs;
- enhance company's image in the community; and
- reduce risk of criminal and civil liability.

This Guidance manual, companion workbook and example worksheets are intended to assist you in developing and implementing a pollution prevention program for your business. It starts by identifying policy, organizational and procedural characteristics which can support and promote pollution prevention, followed by ideas for identifying possible pollution sources and proposals for setting priorities for implementation of prevention plans. It will also help you decide which aspects of your operation you should assess and how detailed the assessment should be.

This chapter provides background information on pollution prevention. Specifically, it:

- Explains what pollution prevention is and what it is not.

Those companies "struggling to maintain compliance today may not be around by the end of the '90s. Those toeing the compliance line will survive. But those viewing the environment as a strategic issue will be leaders"

- Richard W. MacLean, chief, environmental programs, Arizona Public Service Co., as quoted in Environmental Business Journal, Dec, 1991.

- Describes the Environmental Management Hierarchy being promoted by the Ontario Ministry of the Environment and Energy.
- Provides an overview of provincial and federal legislation on pollution control, and presents the government's new strategy towards prevention.
- Summarizes the benefits you can obtain from a company-wide pollution prevention program that integrates raw materials, supplies, chemicals, energy, and water use.

TOTAL QUALITY MANAGEMENT AND POLLUTION PREVENTION

For those organizations and managers who have proceeded down the road of Total Quality Management (TQM), a great deal of the information and approaches described here for pollution prevention should sound very familiar.

Pollution Prevention and TQM share the core belief that if the management of the facility breaks down organizational barriers, and gives all of its employees authority and accountability, they will bring back the best possible ideas.

Total quality is based on the premise that to improve quality you need to change the processes that produce defects. Pollution may be fundamentally considered a proxy for waste in the production process. Changing the process with a commitment to quality can prevent the "defect" of pollution, avoiding the necessity of costly "rework" after it is created.

Pollution prevention is a multi-media activity that cuts across all environmental programs within a facility. It is essential that these programs within a facility encompass all impacts of a process or activity on air, water, waste generation and disposal, and energy use. This is more efficient from the perspective of resource allocation, on an environmental level, because facilities with multiple media impacts can be served by one effort rather than several. However, for all these efficiencies, only by bringing all employees of a facility into the loop - educating them on prevention, encouraging them to apply the principles to their work and constantly improve them, listening to their ideas will you make pollution prevention a fundamental building block in your management of the environment. Chapter 5 - Maintaining The Pollution Prevention Program - provides additional TQM information and suggestions.

Total quality is to management what pollution prevention is to the environment.

TQM offers to provide the essential framework for implementing prevention goals - the transition to a Pollution Prevention culture requires the full use of TQM principles.

In an industrial company with environmental impacts, there is a natural tendency for pollution prevention to emerge as the policy of choice when total quality principles are applied to environmental management.

THE ENVIRONMENTAL MANAGEMENT HIERARCHY

Pollution Prevention is achieved through the preferential approach of source reduction, reuse of product and non-product outputs, or closed loop recycling.

Preventing or recycling at the source eliminates the need for off-site recycling or treatment and disposal. Elimination of pollutants at or near the source is typically less expensive than collecting, treating, and disposing of wastes. It also presents much less risk to your workers, the community, and the environment.

The Ontario Ministry of Environment and Energy has adopted the Environmental Management Hierarchy model as defined in the USEPA's Pollution Prevention Act of 1990. It is illustrated in Figure 1.1.

FIGURE 1.1
THE ENVIRONMENTAL MANAGEMENT OPTIONS HIERARCHY

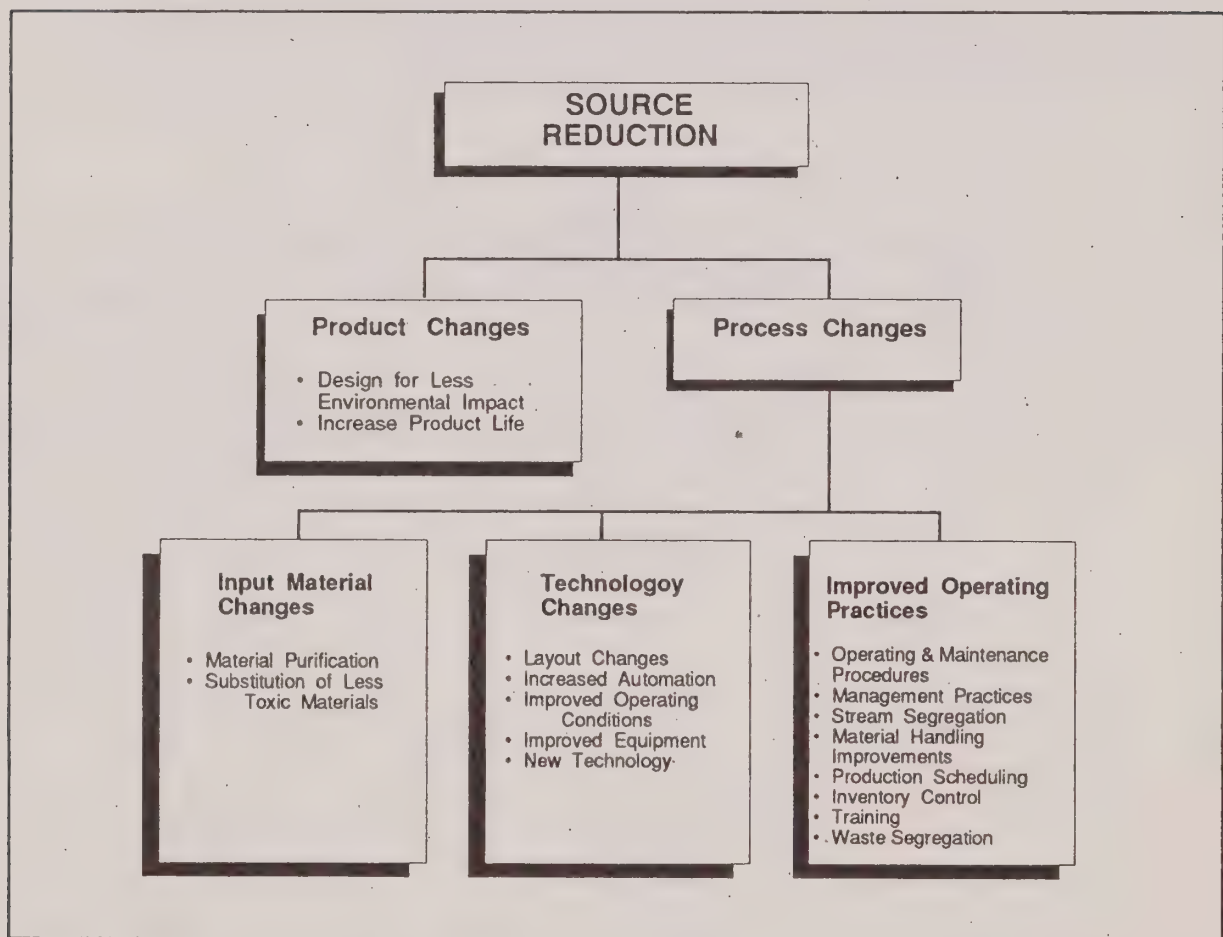
MANAGEMENT METHOD	EXAMPLE ACTIVITIES	EXAMPLE APPLICATIONS
Source Reduction (Highest Priority)	<ul style="list-style-type: none">• Environmentally Friendly Design of New Products• Process Changes• Source Elimination• Reuse of Product & Non-product Outputs• Closed loop recycling	<ul style="list-style-type: none">• Modify Product to Avoid Solvent Use• Modify Product to Extend Coating Life• Solvent recovery and return to process (hard-piped)• Reuse of product and non-product outputs as raw materials
Recycling (Off-site)	<ul style="list-style-type: none">• Reclamation	<ul style="list-style-type: none">• Industrial Waste Exchange• Metal Recovery From a Spent Plating Bath• Recovery/ regeneration of catalysts
Treatment	<ul style="list-style-type: none">• Stabilization• Neutralization• Precipitation• Scrubbing	<ul style="list-style-type: none">• Thermal Destruction of Organic Solvent• Precipitation of chemicals From a Spent Bath
Disposal	<ul style="list-style-type: none">• Disposal at a Licensed Facility• Discharge through sewers• Discharge to water courses	<ul style="list-style-type: none">• Land Disposal• Waste Processing Site

WHAT IS POLLUTION PREVENTION?

Pollution prevention is the maximum feasible reduction of all wastes generated at production sites. It involves the application of best management practices, judicious use of resources through source reduction, energy efficiency, reuse of input materials during production, and reduced water consumption.

Two general methods of source reduction that are useful in a pollution prevention program are: product changes and process changes. They can reduce the quantity and/or toxicity of production wastes and of end-products during their life-cycle and at disposal. Figure 1.2 provides some examples.

FIGURE 1.2
EXAMPLES OF SOURCE REDUCTION METHODS



Product changes are concerned with the qualities of the final product of a process or manufacturing system. These qualities can be affected by design and result in less harmful environmental impact. Product changes and their design are discussed in detail in Chapter 7 of this guide.

Process changes are concerned with how the product is made. They include input material changes, technology changes, and improved operating practices normally attained through implementation of Best Management Practices. All such changes reduce worker exposure to pollutants during the manufacturing process. Typically, improved operating practices can be implemented more quickly and at less expense than input material and technology changes. Box 1 provides examples of process changes.

Box 1 - POLLUTION PREVENTION PROCESS CHANGES

The following process changes are pollution prevention measures because they reduce the amount of waste created during production.

Examples of input material changes:

- Stop using heavy metal pigment.
- Use a less hazardous or toxic solvent for cleaning or as coating.
- Purchase raw materials that are free of trace quantities of hazardous or toxic impurities.
- Raw material substitution to eliminate Schedule 1 wastes (Regulation 347).

Examples of technology changes:

- Redesign equipment and piping to reduce the volume of material contained, cutting losses during batch or colour changes or when equipment is drained for maintenance or cleaning.
- Change to mechanical stripping/cleaning devices to avoid solvent use.
- Change to a powder-coating system.
- Install a hard-piped vapour recovery system to capture and return vaporious emissions.
- Use more efficient motors.
- Install speed control on pump motors to reduce energy consumption.

Examples of Best Management Practices:

- Train operators.
- Cover solvent tanks when not in use. Separate waste streams to avoid cross-contaminating hazardous and nonhazardous materials.
- Improve control of operating conditions (e.g., flow rate, temperature, pressure, residence, time, stoichiometry).
- Improve maintenance scheduling, record keeping, or procedures to increase efficiency.
- Optimize purchasing and inventory maintenance methods for input materials.
- Purchasing in quantity can reduce costs and packaging material if care is taken to ensure that materials do not exceed their shelf life.
- Reevaluate shelf life characteristics to avoid unnecessary disposal of stable items.
- Stop leaks, drips, and spills.
- Turn off electrical equipment such as lights and copiers when not in use.
- Place equipment so as to minimize spills and losses during transport of parts or materials.
- Use drip pans and splash guards.

WHAT IS NOT POLLUTION PREVENTION?

There are a number of measures that are applied only after wastes are generated. They are, therefore, not correctly categorized as pollution prevention. Box 2 provides some examples of procedures that are waste handling, not pollution prevention, measures.

Box 2

The following are not pollution prevention measures because they are applied after the waste is created:

. Off-site recycling:

Off-site recycling is vastly preferable to other forms of waste handling because it helps to preserve raw materials and reduces the amount of material that will require disposal. However, compared with closed-loop recycling (or reuse), performed at the production site, there is likely to be more residual waste that will require disposal. Further, waste transportation and the recycling process itself carry the risks of worker exposure and of release into the environment.

. Waste treatment:

Waste treatment involves changing the form or composition of a waste stream through controlled reactions to reduce or eliminate the amount of pollutant, its toxicity and/or its disposal site space requirements. Examples include detoxification, incineration, decomposition, stabilization, and solidification or encapsulation.

. Concentrating hazardous or toxic constituents to reduce volume:

Volume reduction operations, such as de-watering, are useful treatment approaches, but they do not prevent the creation of pollutants. For example, pressure filtration and drying of a heavy metal waste sludge prior to disposal decreases the sludge water content and waste volume, but it does not decrease the amount of heavy metal in the sludge.

. Diluting constituents to reduce hazard or toxicity:

Dilution is applied to a waste stream after generation and does not reduce the absolute amount of hazardous constituents entering the environment. Dilution is not an acceptable method of waste treatment, and is expressly discouraged or prohibited by both Regulation 347 and MISA.

. Transferring hazardous or toxic constituents from one environmental medium to another:

Many waste management practices to date have simply collected pollutants and moved them from one environmental medium to another. For example, solvents can be removed from waste water by means of an activated carbon absorbers. However, regenerating the carbon requires the use of another solvent or heating, which transfer the waste to the atmosphere. In some cases, transfer is a valid treatment option. However, too often the purpose has been to shift a pollutant to a less tightly regulated medium. In either case, media transfers are not pollution prevention.

POLLUTION PREVENTION REGULATORY FRAMEWORK

ONTARIO

The Ontario Ministry of the Environment was established in 1972 to consolidate responsibility for all aspects of environmental protection, enhancement and restoration under one provincial government agency.

The consolidation involved two government agencies, the Department of the Environment and the Ontario Water Resources Commission, with the new ministry inheriting the operating legislation from each of its predecessors.

In a more recent reorganization of the Ontario government, the ministries of the Environment and Energy were combined in February of 1993 to form a single ministry.

THE ENVIRONMENTAL PROTECTION ACT (EPA)

The general provisions of the EPA cover all types of pollution, forbidding the discharge of any contaminant to the natural environment in amounts, concentrations or levels exceeding those prescribed by regulation. A contaminant is defined as a solid, gas, liquid, odour, heat, sound, vibration, radiation or combination of any of these, resulting directly or indirectly from human activities, which may cause injury to humans, flora or fauna.

In addition to regulated limits for specific contaminants, the EPA prohibits any discharge that is likely to impair the natural environment, injure or damage plant or animal life, cause harm or discomfort to any person, affect the health or safety of any person or render any property, plant or animal life unfit for human use.

ONTARIO WATER RESOURCES ACT

This act gives Environment Ontario extensive powers to regulate water supply, sewage disposal and the control of water pollution. It authorizes the ministry to supervise and examine all surface waters and ground waters in Ontario to determine the extent, nature and causes of contamination in these waters.

Under the Ontario Water Resources Act, any discharge into a body of water, on its shore or in any place that may impair the quality of the water, is an offence. It is also an offence to make any discharge that directly or indirectly causes injury to a person, animal or bird through the use or consumption of any plant, fish or other living matter in the water.

ENVIRONMENTAL ASSESSMENT ACT (EAA)

This act provides for the assessment of any proposed major undertaking whether governmental, municipal or private at the very earliest stage so that it may be altered or even cancelled if it is found to be environmentally unacceptable. The act also provides for full public participation in the decision-making process. It is being implemented in stages, applying first to major provincial undertakings. Specific private projects which involve significant environmental effects may be designated for assessment.

Under the EAA, any proponent of an undertaking submits to the ministry an environmental assessment on the proposal. All interested parties are given an opportunity to examine this document and may request that a public hearing be called by the Environmental Assessment Board.

PESTICIDES ACT

This legislation restricts the storage, distribution, sale and use of pesticides. The ministry examines and licenses professional exterminators and maintains a classification system to ensure that hazardous chemical pesticides are not handled or used by unqualified persons.

CONSOLIDATED HEARINGS ACT, 1981

When the Environmental Assessment Act was first applied to significant municipal projects, one of the main concerns raised by municipalities was the planning and approval processes required, especially under the Planning Act and the Ontario Municipal Board Act. The Consolidated Hearings Act provides a streamlined approval process for municipal, private and provincial projects or proposed activities which may otherwise require hearings by more than one tribunal. Hearings under this act are conducted by one or more members of the Ontario Municipal Board, the Environmental Assessment Board or both as chosen by the chairpersons of the two boards. The streamlining of hearings under the Consolidated Hearings Act is aimed at avoiding the possibility of repetitive, expensive, complex and time-consuming approval procedures.

ONTARIO WASTE MANAGEMENT CORPORATION ACT, 1981

This act established the Ontario Waste Management Corporation with powers to provide, develop and manage facilities for the treatment and disposal of liquid and hazardous waste generated by industry. The powers of the corporation include a mandate to encourage recycling and reduction of these wastes at their industrial sources.

ENVIRONMENT STATUTE LAW AMENDMENT ACT

The newest amendments to the Environmental Protection Act, the Ontario Water Resources Act and the Pesticides Act are contained in the Environment Statute Law Amendment Act, which came into force on June 29, 1988. This act clarifies the ministry enforcement and inspection powers and provides greater precision and protection of individual rights. In addition, the act provides that anything produced to a provincial officer or in plain view during an inspection may be seized if the officer reasonably believes that there has been a contravention of the acts or their regulations. Finally, other amendments ensure greater fairness in the hearing and appeal procedures.

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA)

Under the CEPA, the federal environment departments are enabled to initiate studies within the provinces and issue regulations affecting national environmental interests (e.g. industrial groups such as the pulp & paper industry and national environmental programs such as global warming/ CO₂, acid rain and NO_x VOCs). Under CEPA the federal government may set operating requirements for facilities, emission limits for pollutants and enter into bilateral partnerships with the provinces of Canada and states of the USA.

BENEFITS OF A POLLUTION PREVENTION PROGRAM

In the case of pollution prevention, the national environmental objectives and the socio-economic interests of industry coincide. There are strong social and economic incentives for the reduction of both the toxicity and overall volume of wastes generated. As a result of the World Summit Conference in Rio de Janeiro, society is beginning to recognize the real economic, environmental and health costs associated with waste and pollution. As a result, those companies and facilities which operate and implement an effective, ongoing pollution prevention program will be the ones with a lower cost and have a significant competitive edge. The cost per unit produced will decrease as pollution prevention measures lower liability risk and operating costs. And as societies environmental awareness continues to grow, these same companies will benefit from an enhanced public image associated with its pollution prevention efforts.

There are numerous benefits of a pollution prevention program, as well as many opportunities for environmental and economic improvement. These benefits can be grouped together under five main categories: Legislative and regulatory compliance; direct operating costs; indirect operating costs; environmental risk and liability; and corporate and public image.

I. Legislative and Regulatory Compliance

Ministry Policies are always changing to reflect improvements in the understanding of environmental risks and problems. Associated with this, the Ministry and the federal governments has set limits for the discharge and transfer of certain pollutants and wastes, and has identified other priority areas that may eventually involve some form of regulation. Incorporating this type of long term policy direction in a pollution prevention plan will allow a company to plan for change over a longer term.

Current Regulations require that companies obtain a variety of approvals, and in some cases monitor and document discharge levels and waste handling practices. Where these programs identify situations contrary to current regulations, the onus is clearly on the company and its management to ensure corrective efforts are made. A pollution prevention plan will allow you to anticipate and eliminate "surprises" and provide a mechanism to choose the best options for implementation of corrective or pro-active action.

Municipalities are becoming more careful with respect to the acceptance of waste materials (e.g Sewer-Use By-Laws and waste disposal site use restrictions). The options available for waste disposal are becoming limited, with the emphasis shifting to "at source" methods of dealing with waste. If overall waste volumes are reduced or eliminated, these problems are minimized.

II. Direct Operating Costs

Reduced Operating Costs An effective pollution prevention program can yield cost savings that will more than offset program development and implementation costs. Cost reductions may be immediate savings that appear directly on the balance sheet or anticipated savings based on avoiding potential future costs. Cost savings are particularly noticeable when the costs resulting from the treatment, storage, or disposal of wastes are allocated to the production unit, product, or service that produces the waste. Refer to Chapter 6 for more information on allocating costs.

Materials costs can be reduced by adopting production and packaging procedures that consume fewer resources, thereby creating less waste. As wastes are reduced, the percentage of raw materials converted to finished products increases, with a proportional decrease in materials costs.

"Above all, companies want to pin down risk... Because the costs can be so enormous, risk must now be taken into account across a wide range of business decisions."

- Bill Schwalm, senior manager, environmental programs at Polaroid, in a business interview with Environmental Business Journal, December, 1991.

Waste management and disposal costs are an obvious and readily measured potential savings to be realized from pollution prevention. Federal and provincial regulations mandate special in-plant handling procedures and specific treatment and disposal methods for, toxic wastes. The costs of complying with these requirements and reporting on waste disposition are direct costs to businesses. There are also indirect costs, such as higher taxes for such public services as landfill management. The current trend is for these costs to continue to increase at the same or higher rates. Some of these cost savings are summarized in Box 3.

BOX 3

Waste management costs decrease as prevention measures are implemented:

- Reduced manpower and equipment requirements for on-site pollution control and treatment
- Less waste storage space, freeing more space for production
- Less pretreatment and packaging prior to disposal
- Smaller quantities treated, with possible shift from treatment, storage, and disposal (TSD)
- Identify facility as moving towards non-TSD status
- Less need to transport for disposal
- Reduced paperwork and record-keeping requirements, e.g., less Toxic Release Inventory (NPRI) reporting when NPRI-listed chemicals are eliminated or reduced.

Production costs can be reduced through a pollution prevention assessment. When a multi-disciplinary group examines production processes from a fresh perspective, opportunities for increasing efficiency are likely to surface that might not otherwise have been noticed. Production scheduling, material handling, inventory control, and equipment maintenance are all areas that can be optimized to reduce the production of waste of all types and also control the costs of production.

Energy costs will decrease as pollution prevention measures are implemented in various production lines. In addition, energy used to operate the overall facility can be reduced by doing a thorough assessment of how various operations interact. Chapter 8 discusses energy conservation.

III. Indirect Operating Costs

Employees are likely to feel more positive toward their company when they believe that management is committed to providing a safe work environment and is acting as a responsible member of the

The development of Human Health-Based Risk Assessment Guidelines is being considered by Health & Welfare Canada. These assessments quantitatively estimate the risk of:

- *different remediation techniques for a contaminated site;*
- *new or interim clean-up criteria for a contaminated medium;*
- *practical or intermediate clean up criteria where existing criteria are not practical;*
- *worker exposure being within safe levels for a given situation.*

community. By participating in pollution prevention activities, employees can interact positively with each other and with management. Helping to implement and maintain a pollution prevention program should increase their sense of identity with company goals. This positive atmosphere helps to retain a competitive workforce and to attract high-quality new employees.

Workers' compensation costs and risks are directly related to the volume of hazardous materials used or produced and past history of work related accidents. The comprehensive pollution prevention assessment required to identify potential environmental improvements could also identify workplace health and safety gains.

Financing costs can be reduced where a company is demonstrating to lending institutions that the company is making every effort to operate both in a responsible fiscal manner and also to reduce the risk of pollution. Environmental questionnaires and audits are being requested more often, particularly when borrowing against secured assets. The pollution prevention planning process could play a key role in demonstrating corporate commitment to good management and environmental practices.

IV. Environmental Risk and Liability

Reduced Risk of Liability: You will decrease your risk of both civil and criminal liability by reducing the volume and the potential toxicity of the vapour, liquid, and solid discharges you generate. You should look at all types of waste, not just those that are currently defined as hazardous. Since toxicity definitions and regulations change, reducing the volume of wastes in all categories is a sound long-term management policy.

Facility cleanup and decommissioning costs may result from a need to comply with future regulations or to prepare a production facility or off-site waste storage or disposal site for sale. These future costs can be minimized by acting now to reduce the amount of wastes of all types that you generate. Where companies can implement pollution prevention there will be less risk of waste or pollution accumulation on-site requiring extensive and costly clean-ups during decommissioning.

In a recent Ontario case, the court was critical of cost-cutting measures imposed by a Vice President which "overloaded" one of his more junior officers leaving him insufficient time to deal with environmental issues. Both the President and Vice President of Bata Industries Limited were convicted of failing to take "all reasonable care to prevent the corporation from causing or permitting an unlawful discharge" under the OWRA.

Environmental legislation: Some provincial regulations (e.g. MISA) require that facilities document the emissions for a range of toxic, hazardous, non-hazardous and conventional pollutants. Companies that produce excessive emissions risk heavy fines, and their managers may be subject to fines and imprisonment if potential pollutants are mismanaged. Civil liability is decreased by generating less hazardous waste and other potential pollutants. Waste handling affects public health and property values in the communities surrounding production and disposal sites. Even materials not currently covered by hazardous waste regulations may present a risk of civil litigation in the future under the Environmental Bill of Rights (EBR).

V. Corporate and Public Image

Improved Company Image: As the quality of the environment becomes an issue of greater importance to society, your company's policy and practices for controlling waste increasingly influence the attitudes of your employees and of the community at large.

Community attitudes will be more positive toward companies that operate and publicize a thorough pollution prevention program. Most communities actively resist the siting of new waste disposal facilities in their areas. In addition, they are becoming more conscious of the monetary costs of treatment and disposal. Creating environmentally compatible products and avoiding excessive consumption and discharge of material and energy resources, rather than concentrating solely on treatment and disposal, will greatly enhance your company's image within your community and with potential customers.

Public Health and Environmental Benefits: Reducing production wastes provides upstream benefits because it reduces the potential for ecological damage due to raw material extraction and refining operations. Subsequent benefits are the reduced risk of emissions during the production process and during recycling, treatment, and disposal operations.

DEVELOPING THE POLLUTION PREVENTION PLAN

Pollution prevention planning is a comprehensive and continual evaluation of how you do business. The planning process and resulting program will affect many if not all of the functional areas within your company. It has much in common with the planning you already do for other aspects of your business operations and is a significant part of the overall life cycle management approach.

Figure 2.2 illustrates the major steps in the pollution prevention program. These steps are described in this chapter and in Chapters 3 through 5.

This chapter considers the elements of pollution prevention program design as they might be addressed by a company. These elements include building support for pollution prevention throughout the company, organizing the program, setting goals and objectives, performing a preliminary assessment of pollution prevention opportunities, and identifying potential problems and their solutions.

ESTABLISH THE POLLUTION PREVENTION PROGRAM

Executive Level Decision

In some companies, the initiative to investigate setting up a pollution prevention program will be taken at the executive level. In others, lower-level managers or employees will be the catalysts. In either case, it may be necessary to gather information to demonstrate that pollution prevention opportunities exist and should be explored. This information will be used by company executives as they weigh the potential value of pollution prevention and decide whether to commit the resources necessary to develop and implement the program.

One way to gather this information is to perform a preliminary assessment. A pre-assessment is part of the formal program design effort and is, therefore, described later in this chapter. However, a high-level pre-assessment of only one or two areas of the facility can be done to gather information and, perhaps, even identify several low-cost, quick-payoff pollution prevention techniques that can be implemented readily.

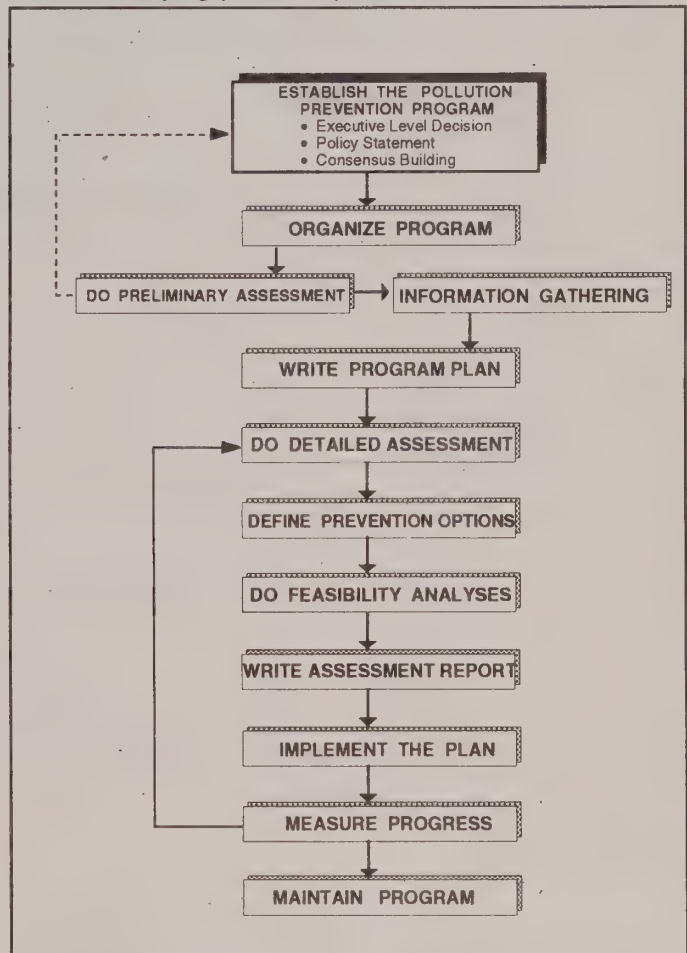


Figure 2.1 Establish Program

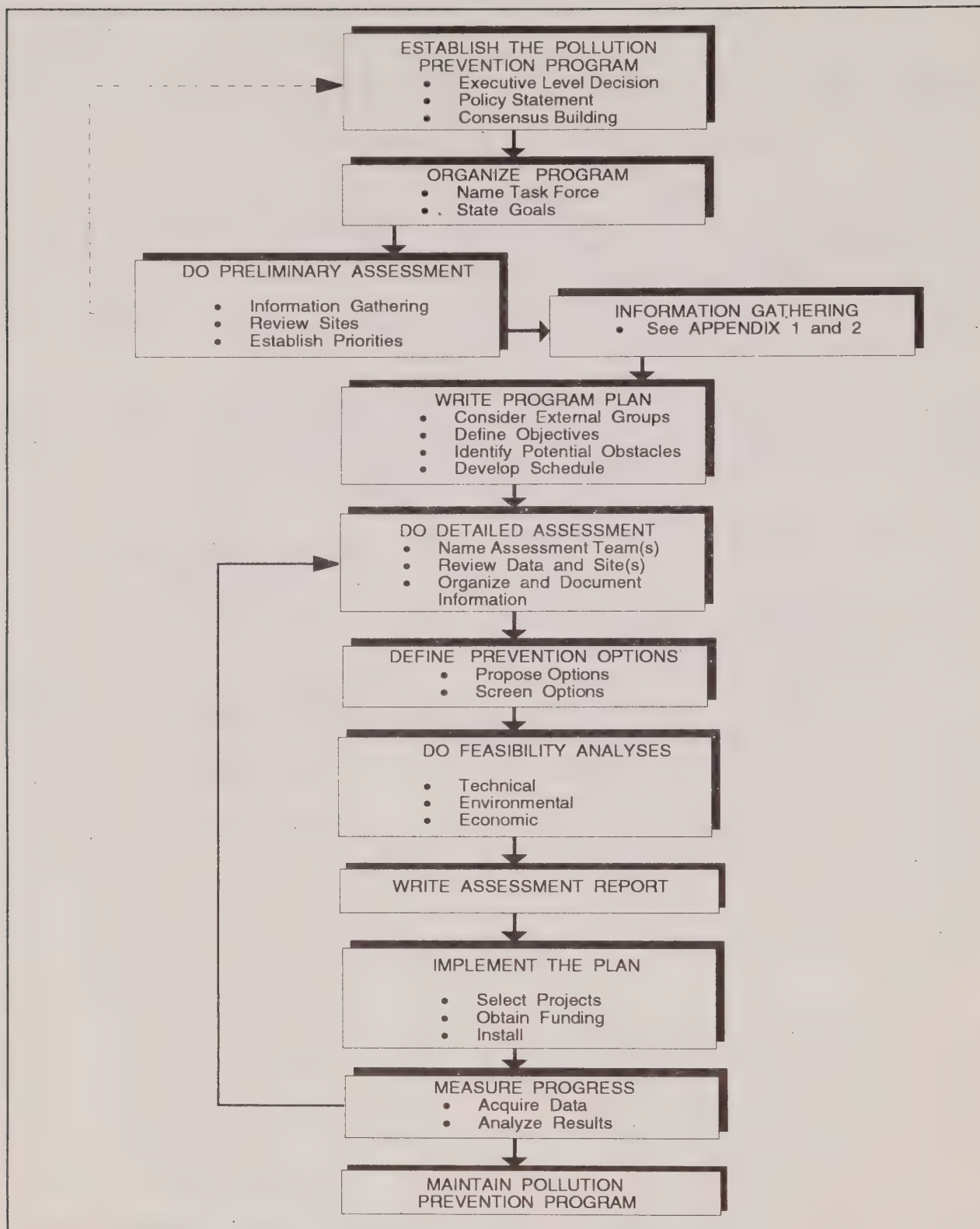


Figure 2.2 Pollution Prevention Program Overview

Once senior managers have decided to establish a pollution prevention program, they should convey this commitment to all employees through a formal policy statement. This will establish the formal commitment throughout the organization.

Policy Statement

As with other policy statements your company develops, your pollution prevention policy statement should state why a program is being established, what is to be accomplished in qualitative program terms, and who will do it. Two example policy statements are given in Box 4. They differ in level of detail, but both answer these key questions:

The policy statement is the foundation of the pollution prevention program.

Q. Why are we implementing pollution prevention?

A. *We want to protect the environment.*

Q. What will be done to implement pollution prevention?

A. *We will review all sources and types of waste at our site and identify and implement all possible (technically and economically feasible) opportunities.*

Q. Who will implement pollution prevention?

A. *Everyone from our location (site, office, plant, etc) will be involved.*

Consensus Building

After you have developed your pollution prevention policy statement, consider how it should be presented to your employees so that they will see it as an ongoing, company-wide commitment.

It is essential that employees understand and support the pollution prevention program.

While executives and managers will assign priorities and set the tone for the pollution prevention program, the attitude of production-level employees will have a significant effect on its success. Since it is their daily activities that generate waste, their support of the program is essential.

How you publicize the policy depends on the size and the culture of your company. You may decide to call a general meeting or to hold several meetings with smaller groups. There may be other types of publicity that you have found to be effective.

Involvement at all levels demonstrates a total quality management approach which recognizes that participation by all employees is crucial to the overall success of the program.

You might offer bonuses or other awards to employees who suggest ways to prevent pollution. Announcing awards in newsletters or on bulletin boards provides additional incentive to employees and further publicizes the program. Pollution prevention might be included in job objectives and performance evaluations for managers and other appropriate employees.

In any case, it is important to emphasize your company's commitment to pollution prevention and encourage employee participation. This will help to establish a positive atmosphere and reassure employees who might be concerned about the changes that will result.

- " POLICY STATEMENT EXAMPLE 1--"(Your Company Name) is committed to excellence and leadership in protecting the environment. In keeping with this policy, our objective is to reduce waste and emissions. We strive to minimize adverse impact on the air, water, and land through pollution prevention and energy conservation. By successfully preventing pollution at its source, we can achieve cost savings, increase operational efficiencies, improve the quality of our products and services, maintain a safe and healthy workplace for our employees, and improve the environment. (Your Company Name)'s environmental guidelines include the following:
- Environmental protection is everyone's responsibility. It is valued and displays commitment to (Your Company Name).
 - We will commit to including pollution prevention and energy conservation in the design of all new products and services.
 - Preventing pollution by reducing and eliminating the generation of waste and emissions at the source is a prime consideration in research, process design, and plant operations. (Your Company Name) is committed to identifying and implementing pollution prevention opportunities through encouraging and involving all employees.
 - Technologies and methods which substitute nonhazardous materials and utilize other source reduction approaches will be given top priority in addressing all environmental issues.
 - (Your Company Name) seeks to demonstrate its responsible corporate citizenship by adhering to all environmental regulations. We promote cooperation and coordination between industry, government, and the public toward the shared goal of preventing pollution at its source."
- " POLICY STATEMENT EXAMPLE 2--"At (Your Company Name), protecting the environment is a high priority. We are pledged to eliminate or reduce our use of toxic substances and to minimize our use of energy and generation of all wastes, whenever possible. Prevention of pollution at the source is the preferred alternative. When waste cannot be avoided, we are committed to recycling, treatment, and disposal in ways that minimize undesirable effects on air, water, and land."

(Adapted from: Waste Reduction Institute for Training and Applications Research, Inc. [WRITAR], *Survey and Summaries*, 1991, and Minnesota Office of Waste Management, Feb. 1991, *Minnesota Guide to Pollution Prevention Planning*)

BOX 4

This approach will also elicit worthwhile pollution prevention suggestions (Box 5).

Employees feel committed to pollution prevention when they are encouraged to:

- Help define company goals and objectives.
- Review processes and operations to determine where and how toxic substances are used and hazardous wastes are generated.
- Recommend ways to eliminate or reduce waste production at the source.
- Design or modify forms and records to monitor materials used and waste.
- Find ways to involve suppliers and customers.
- Think of ways to acknowledge and reward employee contributions to the pollution prevention effort.

BOX 5

ORGANIZE THE POLLUTION PREVENTION PROGRAM

The program will be directed by the Pollution Prevention Task Force. Their first task will be to delineate program goals.

Name the Pollution Prevention Task Force

The people who will direct the pollution prevention program should be selected carefully. They will have overall responsibility for developing the plan and directing its implementation. Their capabilities and their attitudes toward the effort will be major determinants of how successful it is. As with other areas of your operation, successful program execution will require integration and continuity of the planning, implementation, modification, and maintenance stages. **Therefore, all individuals named to this task force should have substantial technical, business, and communication skills as well as thorough knowledge of the company.** The responsibility and authority of each individual should be established during this organizational stage.

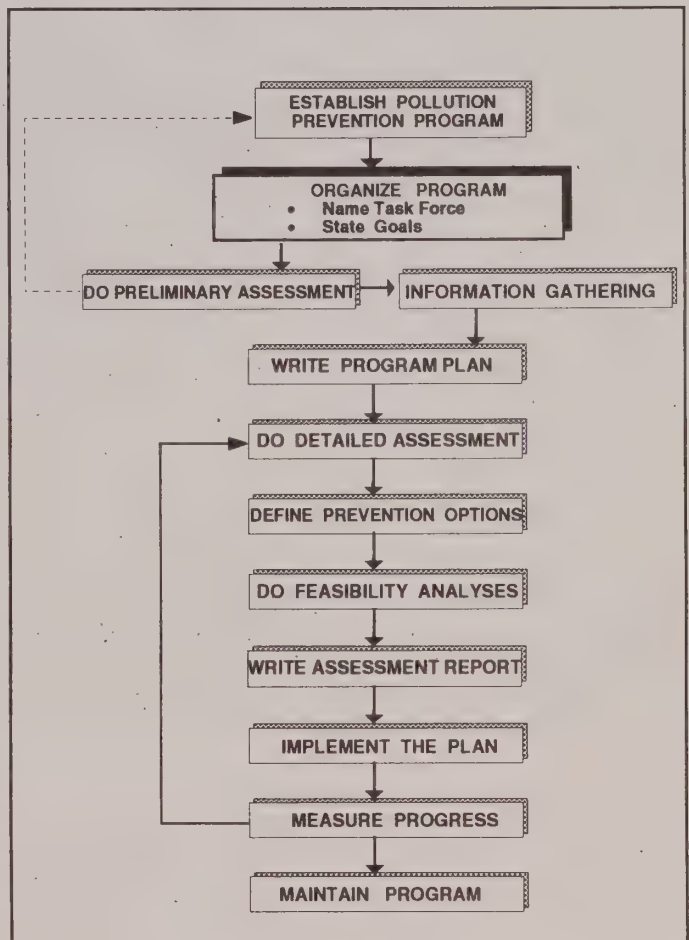


Figure 2.3 Organize Program

The **program leader** should be named from the highest level practical. The leader must have the authority and the influence necessary to keep the program on track and to ensure that pollution prevention becomes an integral part of the overall corporate plan. The role of the leader is to facilitate the flow of information among all levels in the company. Therefore, the leader should possess the personal qualities necessary to elicit broad-based support from the company's employees.

The task force will direct the development and implementation of the pollution prevention program and help integrate its principles into all phases of corporate planning.

One or more **pollution prevention champions** should be designated. The task of a "champion" is to overcome possible resistance to proposed changes in operations. In a medium-sized company, several champions may be assigned, perhaps according to production area. In a very small company, the champion may also be the program leader. Champions will be the team members who are the most visible within the production areas and should be respected and trusted at all levels in order to perform this liaison role well.

Other team members might be selected for their specific technical or business expertise. Environmental and plant process engineers, production supervisors, and experienced line-workers are good candidates. Other potential sources include purchasing and quality-assurance staff. In some cases, outside consultants may be retained to work with the in-house team. Once the task force has been established, they will be a valuable resource within the company. When plans are being made to expand the facility or to design or redesign products, they can review the plans to determine whether waste generation has been evaluated thoroughly.

State Goals

The program leaders will need to establish goals that state the long-term direction for the pollution prevention program. Well defined goals will help to focus effort and build consensus. Goals should be consistent with your company's pollution prevention policy and, in fact, may have been stated in general terms in the policy statement. Now, they need to be stated more specifically.

Goals should be:

- well-defined*
- meaningful to all employees*
- challenging yet achievable*
- flexible*
- part of a program planning document.*

The goal-setting process will involve the program team and company management. The size of the group needed to develop the goals depends on the size and complexity of your facility. For a small company, the group might be only two or three people.

Since success in pollution prevention may require basic changes in the corporate culture, goals should be useful and meaningful for every employee. Goals need to be challenging enough to motivate but not unreasonable or impractical. When beginning the goal-setting process, consider a long term objective that would involve 100% utilization of resources, eliminating disposal costs and regulatory compliance needs. This long term objective could be achieved by then setting a series of realistic, short term goals against which progress can be easily measured to motivate further improvement. Like zero-defect production goals, zero-discharge goals encourage an attitude of continually striving for improvement.

Pollution prevention goals can be qualitative, such as, "achieve a significant reduction of toxic substance emissions to the environment." But, **while quantitative goals are more challenging to develop, they are worth the extra effort. They spell out your pollution prevention commitment and give all participants and observers a yardstick for measuring progress.**

Finally, goals should be flexible and adaptable. Conditions change in actual practice. As your pollution prevention program becomes more focused and the pollution-specific aspects of the operation become better known, the goals can be refined. They can be adjusted up or down as the program matures and lessons are learned. Periodic goal-achievement review and adjustment will keep your program active and visible within the company.

Your corporate pollution prevention policy and goals should be integrated in a formal planning document.

DO THE PRELIMINARY ASSESSMENT

Even though you may have completed some aspects of the preliminary assessment as input to the executive decision to develop a pollution prevention program, a deeper examination will be needed at this point. The data collection that is a part of this pre-assessment will help the team review the data that are already available and begin defining ways to process that data. These data and the site visits will enable the Task Force to establish priorities and procedures for detailed assessments. Chapter 3 describes the detailed assessment phase and the more in-depth data collection and analyses that will be done at that stage.

Information Gathering

The extent and complexity of the system for collecting pollution prevention data should be consistent with the needs of your company. Keep in mind that the goal of the program is to prevent pollution, not to collect data--the simplest system that fits your needs is the best. Depending on the nature and size of your firm, much of

"In fact there were not really any models we could follow. We learned what the technical issues were. Based on that research, we set a challenging but feasible goal. And in 1988 we made a public pledge to eliminate CFCs within 3 years." "On January 10, 1992, Northern Telecom celebrated "A Clear Day" - a world-wide event marking the removal of ozone depleting chlorofluorocarbons from all of our manufacturing and research operations."

David E. Tostenson,
Director, Health and
Safety & Environment,
Northern Telecom Canada
Ltd. Addressing a TQEM
Seminar, Toronto,
September 23, 1992.

the data needed for a pollution prevention program may be collected as a normal part of plant operations or in response to existing regulatory requirements (See Box 6). The worksheets in Appendix 2 can also be used for the pre-assessment; you may decide to tailor them to fit your particular industry. Other useful information that may assist you in evaluating priorities include those areas such as; company issues, business functions and office-based activities (See Box 7) Appendix 1 provides a guided tour through these three areas and offers a listing of some of the elements you may wish to consider.

A multimedia approach, which deals with all air, water, and solid waste emissions and releases, will be the most effective. This involves considering all waste streams, identifying their sources and quantifying the true costs of pollution control, treatment, and waste disposal. There are a number of information sources to consider.

Regulatory reports

In Ontario, the MISA program, through its monitoring phase, has yielded reports which document the volume, composition, and degree of toxicity of wastewater discharged from nine industrial sectors. Waste manifests as required under Reg 347 will supply information on the quantity and types of hazardous wastes (i.e. classes) transported off-site for disposal.

The toxic substance release inventories which will be required by the Federal Environment under the National Pollutants Release Inventory (NPRI) beginning in 1993 will provide information on emissions into all environmental media. (This will be similar to the current US EPA SARA Title III, Section-313 legislation)

Engineering and operating data

Shipping manifests will provide quantities of raw materials, products and hazardous waste shipped during a given period, but may lack chemical analysis, specific source, and the time period during which the waste was generated. The plant design documents and equipment operating manuals and procedures may yield specific data for streams inside of the plant.

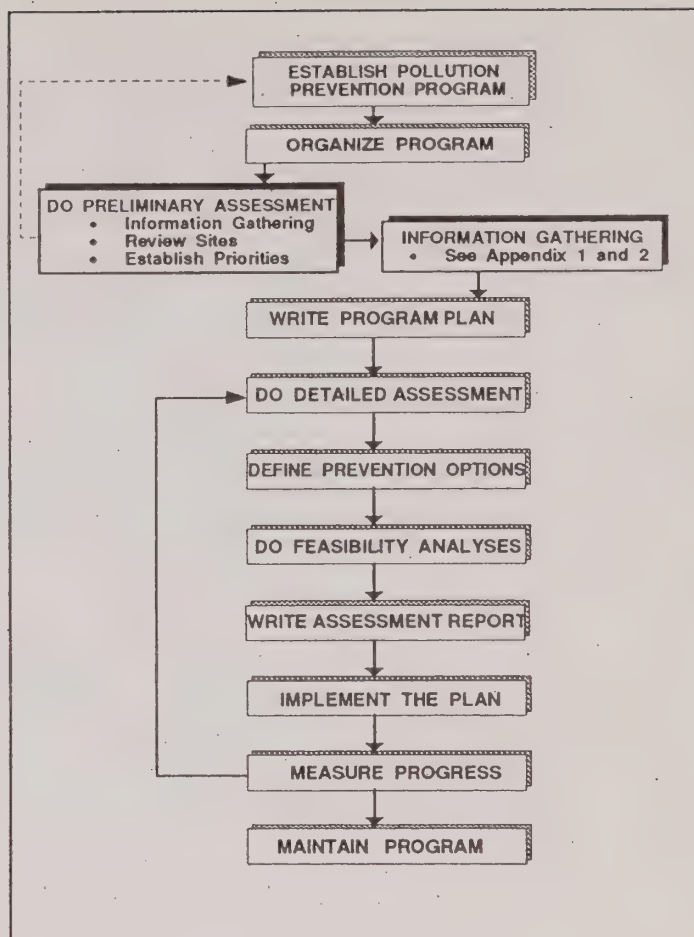


Figure 2.4 Preliminary Assessment

Plant business records

Records available from inventory control, purchasing, records management, accounting, marketing, and training can provide data needed for the pre-assessment and may themselves present opportunities for pollution prevention. For example, improved inventory control and judicious purchasing can significantly reduce the volume of raw materials that must be disposed of because they become outdated. In reviewing existing data, you may find that current accounting practices are not appropriate for placing the burden of pollution and pollution control at the point of generation. These findings should be taken into account when costs of pollution control measures are analyzed. (See Chapter 6.)

Data sources for facility information include:

Regulatory Information:

- Waste shipment manifests (Reg 347)
- Emission inventories
- Hazardous waste storage reports
- Waste, wastewater, and air emissions analyses, including intermediate streams
- Environmental audit reports
- Certificates of Approval and pesticide permits of restricted products
- MISA program monitoring data

Process Information:

- Process flow diagrams
- Design and actual material and heat balances for:
 - production processes
 - pollution control processes
- Operating manuals and process descriptions
- Equipment lists
- Equipment specifications and data sheets
- Piping and instrument diagrams
- Plot and elevation plans
- Equipment layouts and logistics

Raw Material/Production Information:

- Product composition and batch sheets
- Material application diagrams
- Material safety data sheets
- Product and raw material inventory records
- Operator data logs
- Operating procedures
- Production schedules

Accounting Information:

- Waste handling, treatment, and disposal costs
- Water and sewer costs, including surcharges
- Costs for nonhazardous waste disposal, such as trash and scrap metal
- Product, energy, and raw material costs
- Operating and maintenance costs
- Department cost accounting reports

Other Information:

- Environmental policy statements
- Standard procedures
- Organization charts
- Experts and information from industry or engineering associations

BOX 6

INFORMATION GATHERING - ISSUES TO ADDRESS		
COMPANY ISSUES	BUSINESS FUNCTIONS	OFFICE BASED ACTIVITIES
Environmental Policy Performance Targets Management Structure Staff Awareness & Training Public Relations Community Involvement Investment Finance/ Cost Management Legal Compliance Purchasing Policy Market Pressures Emergency/ Contingency Plans Insurance Site/ Building Management	Product Design Raw Materials Packaging Process Design/ Operations Water Use/ Discharge Energy Source/ Use Storage on Site Emissions/ Discharges Solid/ Liquid Waste Management Waste Disposal Transport & Distribution BOX 7	Paper Use Equipment and Furniture Energy Waste Water

Review Sites

In order to utilize resources of time, staff, and money wisely, the task force will need to prioritize the processes, operations, and wastes that will be addressed during the subsequent detailed assessment phase.

Site visits make it possible to:

- prioritize areas.
- select detailed assessment teams

During that phase, they will target the most important waste problems, moving on to lower-priority problems as resources permit. The pre-assessment site visits will provide the information needed to accomplish this prioritization and to designate the detailed assessment teams, who will be selected for their expertise in particular areas.

Typical considerations for prioritizing waste streams for further study include:

- compliance with current and anticipated regulations
- chemicals on the banis and phaseout list
- costs of waste management (pollution control, treatment, and disposal)
- potential environmental and safety liability quantity of waste
- hazardous properties of the waste (including toxicity, flammability, corrosivity, and reactivity)
- other safety hazards to employees
- potential for pollution prevention
- potential for removing bottlenecks in production or waste treatment
- potential recovery of valuable by-products
- available budget for the pollution prevention assessment
- minimizing waste water discharges
- reducing energy use
- availability of alternate materials

BOX 8

Establish Priorities

Assigning priorities (Box 8) to processes, operations, and materials will focus the remainder of the pollution prevention plan development effort. The priorities set in this stage will guide the selection of areas for the detailed assessments. Areas may also be targeted based on the volume of waste produced or the cost of waste disposal. Regulatory concerns such as the MOE list of proposed ban and phaseout substances or the anticipated NPRI list of chemicals may also guide prioritization. The Option Rating Weighted Sum Method, which is illustrated in Appendix 4, can be used during the pre-assessment phase as well as during detailed assessment.

The priorities established at this point will guide subsequent effort.

PREPARE THE PROGRAM PLAN

With the information collected during the pre-assessment, the Task Force can develop a detailed program plan. This plan will address the extent to which external organizations will be involved, define pollution prevention program objectives, identify potential obstacles and solutions, and define the data collection and analysis procedures that will be used. A summary of the points that should be addressed in a program plan appears in Box 9.

Contacting External Groups

At this point, the Task Force should consider soliciting input from outside the company. Including the surrounding community in the pollution prevention planning process can create a new forum for communication. Valuable technical information can also be exchanged with some organizations. The Ontario Ministry of Environment and Energy may be able to provide guidance and support for these types of community actions.

Legislative and executive officials can provide their perspectives on environmental protection issues and information on their planning processes. In return, they can gain information that will help them make decisions on future public issues related to the environment.

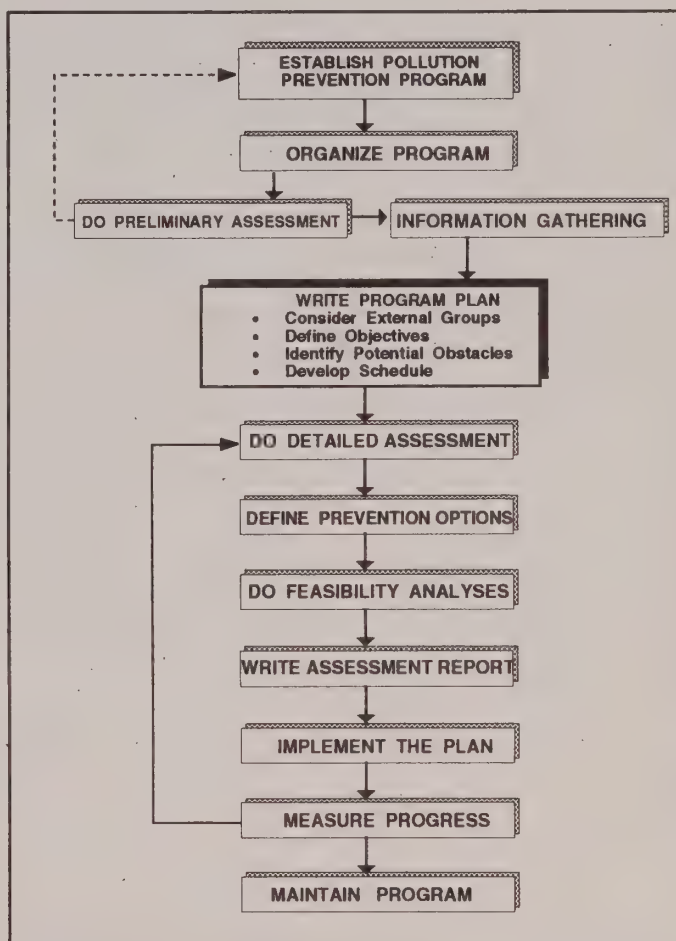


Figure 2.5 Write Program Plan

Community involvement is a good way to build credibility and focus pollution prevention efforts on the discharge paths that most concern your neighbours. While this is no easy matter and is fraught with pitfalls and consideration of details, it is essential the community involvement and notification be tackled early and aggressively. The alternative is to be always under suspicion and having to respond in an ad-hoc manner to the inevitable demands of your local community, environmental groups and the general public. Having a few pollution prevention projects underway will demonstrate your good faith. Positive community involvement can be encouraged through holding open meetings, granting interviews to the media, advertising, direct-mail surveys and opinion polls. There are numerous very successful examples of these activities available through the various industrial member associations and societies.

Other businesses and industrial associations can be a source of information on technical issues and suppliers, either because they are in the same geographical area or because they have similar technical areas of interest. A good example of this is the Canadian Chemical Producers' Association and their "Responsible Care " program. Local business groups are a good way of locating resources in the immediate area, while trade and professional associations can provide contacts in other parts of the country or the world. Of course, the companies with the most similar interests may be competitors, but it should be possible to interact without risking disclosure of business-sensitive information.

Other businesses will have useful information.

The formal written pollution prevention plan will include the following elements:

- Corporate policy statement of support for pollution prevention
- Description of your pollution prevention planning team(s) makeup, authority, and responsibility
- Description of how all of the groups (production, laboratory, maintenance, shipping, marketing, engineering, and others) will work together to reduce waste production and energy consumption
- Plan for publicizing and gaining company-wide support for the pollution prevention program
- Plan for communicating the successes and failures of pollution prevention programs within your company
- Description of the processes that produce, use, or release hazardous or toxic materials, including clear definition of the amounts and types of substances, materials, and products under consideration.
- List of treatment, disposal, and recycling facilities and transporters currently used
- Preliminary review of the cost of pollution control and waste disposal
- Description of current and past pollution prevention activities at your facility
- Evaluation of the effectiveness of past and ongoing pollution prevention activities
- Criteria for prioritizing candidate facilities, processes streams for pollution prevention projects.

BOX 9

Define Objectives

During the preliminary assessment phase, the program team will have identified opportunities for pollution prevention and will have worked with the executive group to establish priorities. These will be the starting point for defining short- and long-range objectives.

Objectives are the specific tasks that will be necessary to achieve goals. For example, in order to reach a goal of reducing waste, the objectives might be defined as reducing solvent, paper, and packaging wastes by specific amounts over a stated period of time.

Objectives can be defined at the facility or the department level, depending on the size and diversity of your company. A small company could decide to develop a single set of objectives to cover all of its operations. A larger company with many facilities or products might develop an overall corporate plan describing goals and objectives, supplemented by facility or product-specific goals. In any case, the management at each location must understand and support its objectives if the pollution prevention program is to be successful.

Objectives should be stated in quantitative terms and should have target dates. These two attributes make objectives effective tools for directing effort and measuring progress.

Identify Potential Obstacles

As the pollution prevention program team begins to develop and implement a pollution prevention program, they are likely to encounter a number of factors that will complicate the process. These need to be recognized, and the means for overcoming them need to be defined. Apparent obstacles will be less likely to impede the process if everyone understands that there is a mechanism for addressing them in a later stage.

The mix of factors and the relative degree of difficulty each presents will vary from company to company. Those that are likely to be encountered by most businesses are discussed below. They fall into four broad categories: **economic, technical, regulatory, and institutional.**

Economic Obstacles. The task force should recognize that some complex economic factors may need to be addressed later. Broadly-defining procedures now for dealing with them will help prevent economic concerns from stifling the creative process of defining options.

Clorox's environmental executives... want to integrate goals already established by plants into corporate-wide objectives that can be quantified and measured to assess progress.

--From an interview with Michael Piley, Director of Environmental Marketing at Clorox. Environmental Business Journal, December, 1991.

Potential economic obstacles include relatively complex cost analysis requirements and the need for capital improvements funding.

Cost-benefit analysis procedures should be defined. Many proposed pollution prevention options will have start-up costs. For example, additional or replacement equipment may need to be purchased, staff training may be required, or alternative raw materials may cost more. Some of these additional costs can be justified readily because they clearly will be cost-effective and will have short pay-back times. However, many will not be so clear-cut and will need more sophisticated analysis. Chapter 6 describes the "Total Cost Assessment" (TCA) approach as it applies to pollution prevention projects and discusses why it may be necessary to look at longer payback times for pollution prevention projects.

Limited financial resources for capital improvements may also be a problem, even for options that will ultimately be profitable. The team should investigate the availability of and conditions for funding assistance or low-interest loans from provincial agencies. Appendix 5 provides information on whom to contact.

Technical Obstacles. Information will be needed on alternative procedures that should be considered, how to integrate them in the production process, and what side effects are possible.

Possible technical obstacles:

- availability of information
- disruption of production
- product quality changes

Technical Information resources could be a problem. As a small or medium-sized business, you may not have ready access to a central source of information on pollution prevention techniques. There are several ways to deal with this problem. Encourage employees to watch for information in the technical journals and newsletters they read and to pass it on to the task force. Those who belong to professional societies may get ideas from other members. Metropolitan or university library reference departments can provide assistance in locating sources of published information as well as names of people who might be able to provide information in specific areas. If the scope of the technical problem and resources permits, it may be appropriate to retain a consultant. Box 10 provides some additional suggestions for securing this information.

Limited flexibility in the manufacturing process may pose another technical barrier. A proposed pollution prevention option may involve modifying the work flow or the product or installing new equipment; implementation could require a production shutdown, with loss of production time. You might be concerned that the new operation will not work as expected or might create a bottleneck that slows production. In addition, the production facility might not have space for pollution prevention equipment. These technical barriers can be overcome by having design and production personnel take part in the planning process and by using tested technology or setting up pilot operations.

Product quality or customer acceptance concerns might cause resistance to change. For example, in some printing and publishing operations it is possible to minimize waste by substituting a water-based ink for a solvent-based ink. But for some products, quality suffers when water-based ink is used. You should plan to avoid potential product quality degradation by verifying customer needs testing the new process or product, and increasing quality control during manufacture.

Regulatory Obstacles. Regulations may be a barrier to some pollution prevention options. For example, changing to another feed material may require changing the existing certificates of approval. In addition, it may be necessary to learn what regulations might apply to proposed alternative input materials.

Working with the appropriate regulatory bodies early in the planning process will help overcome this barrier. Points of contact at the appropriate agencies will be helpful; many are listed in Appendix 5. Also, the Canadian Standards Association (CSA) have identified a number of documents to facilitate pollution prevention efforts by industry; some are listed in Appendix 6.

Your municipal works department may also provide assistance. Industry associations, workgroups, and those currently involved with joint partnerships or projects with local governments might also be contacted.

There are a number of sources of technical assistance:

- **Trade associations** generally provide assistance and information about environmental regulations and various available techniques for complying with these regulations. Their information is especially valuable because it is tailored to the specific industry.
- **Published literature** can be a valuable resource. Articles in technical magazines, trade journals, government reports, and research briefs describe pollution prevention technologies and applications.
- **Federal, Provincial and International environmental agencies** are expanding their pollution prevention technical assistance programs. These programs make available information on industry-specific pollution prevention techniques. (See Appendix 6 for addresses and phone numbers of such resources.)
- **Equipment vendors** and sales literature are helpful in identifying and analyzing potential equipment-oriented options.
- **Consultants** -- Consultants with experience in pollution prevention in the specific industry can usually be located.
- **Other Companies.**

BOX 10

Institutional Obstacles. As with any other new program, general resistance to change and friction among elements within the organization may arise. These can result from many factors, such as lack of awareness of corporate goals and objectives, individual or organizational resistance to change, lack of commitment, poor internal communication, requirements of existing labour contracts, or an inflexible organizational structure.

Resistance to change and friction among organizational elements can be reduced by effective communication.

Analyze these barriers from different perspectives in order to understand the concerns. Management is concerned with production costs, efficiency, productivity, return on investment, and present and future liability. Workers are concerned about job security, pay, and workplace health and safety. The extent to which these issues are addressed in the pollution prevention program will affect the success of the program.

Address these issues from a total quality management perspective.

Institutional barriers can be overcome with education and outreach programs. As was pointed out earlier, it is vital to gain the support of staff at all levels very early in the pollution prevention effort.

Develop Schedule

The final aspect of planning your pollution prevention program is to list the milestones within each of the stages from detailed assessment through implementation and assign realistic target dates. The execution of these stages (described in Chapter 3) should follow this schedule closely. Significant deviations may cause the program to falter because certain steps are not completed. Adherence to the schedule will also help control the start-up or implementation costs of the program.

DEVELOPING AND IMPLEMENTING POLLUTION PREVENTION PROJECTS

This chapter outlines how to execute the pollution prevention program plan that resulted from the activities outlined in Chapter 2. The figure below illustrates the steps that will be discussed in this chapter and places them in the context of the overall effort.

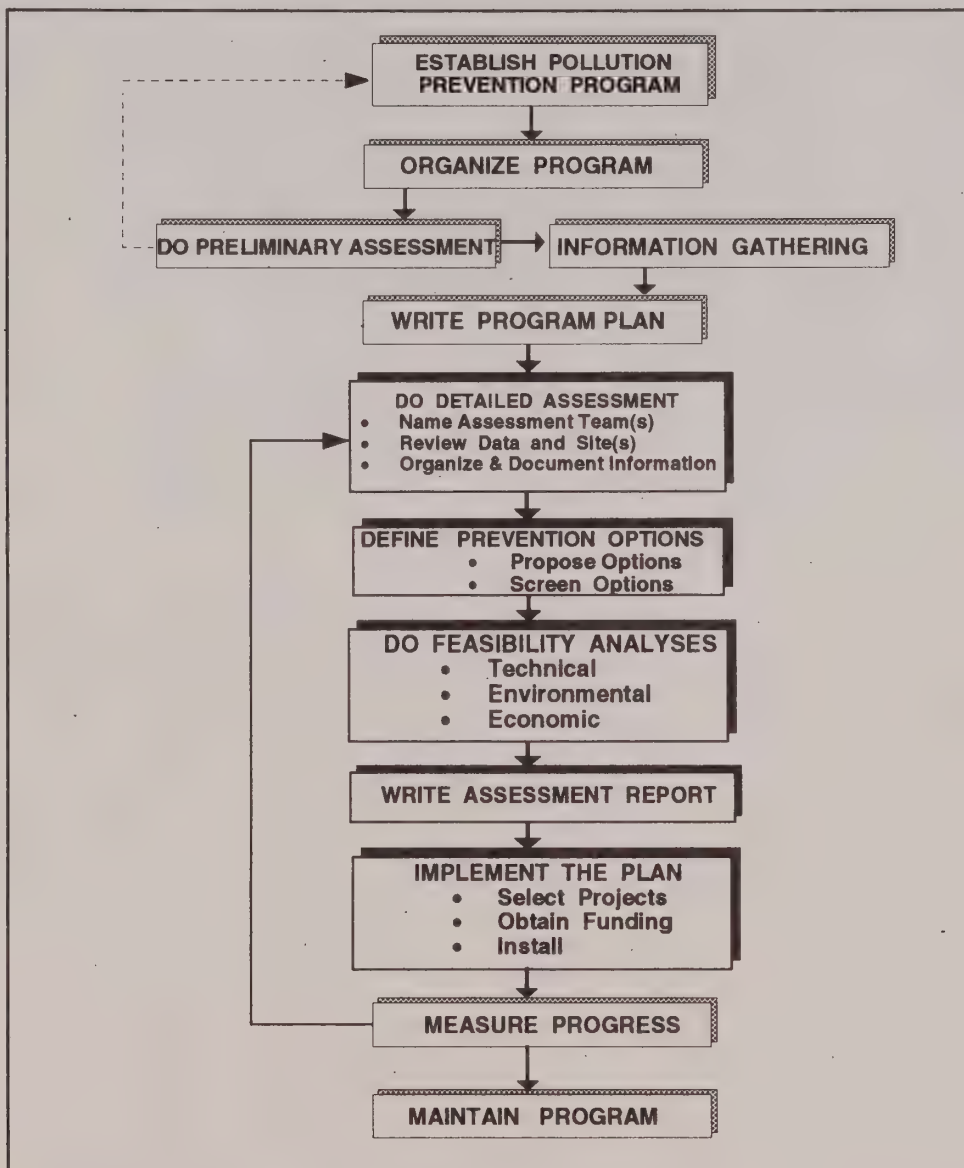


Figure 3.1 Program Development and Implementation

As with the other stages, the degree of formality should be tailored to the size of the company and the diversity of its product lines. Thus, a small company may need to do only one detailed assessment and prepare one implementation plan, while a larger, more diverse company might require several in order to address all production processes. If multiple plans are developed, it will be necessary to examine how they fit together, resolving any conflicts and prioritizing them to fit available resources.

DO DETAILED ASSESSMENT

As part of your program design, you probably did a preliminary assessment of your facility to identify areas of opportunity for pollution prevention. Now, detailed assessments will focus on specific areas targeted by the preliminary assessment.

Assessment teams will be assigned to each operational area of the facility to gather data for later analysis. As was the case during the preliminary assessment, they will use existing written materials and site evaluations. However, they will delve much more deeply into each production process, interviewing workers and compiling necessary data that may not have been collected before. During this process, the team may identify some options that can be implemented quickly and with little cost or risk. It is likely, however, that many options will be more complex and will require in-depth analysis later.

Designate the Detailed Assessment Team(s)

The detailed assessment phase should be started by a member of the pollution prevention task force, which was identified during program design. Unless your company is small enough that the task force and the detailed assessment team are the same, you will need to name additional staff to comprise one or more detailed assessment teams. The focus of each assessment team will be relatively specific. It is likely that three to six people will prove to be a workable number for an assessment team. Specialists can be consulted as needed. Ideally one member of the task force will be included on each team; this will facilitate communication. The additional team members should be people with direct responsibility for and knowledge of the waste streams and/or areas of the facility under consideration. A multidisciplinary team is likely to be more successful in achieving a comprehensive assessment, providing the best input possible to the data analysis and option definition stages, and providing answers to the question of how the pollution prevention plan fits into the overall facility operations. To the extent practical, you should consider engineers, supervisors, and production workers as well as finance and accounting, purchasing, and administrative staff when selecting the team members. This perspective is a prerequisite for thorough assessment of options in

Areas of expertise to consider for detailed assessment teams:

- Management
- Engineering
- Quality control
- Production and maintenance
- Accounting and purchasing
- Legal
- Health and safety
- Research and development

later phases of the pollution prevention plan development cycle. If consultants are on the assessment team, the site review enables them to become familiar enough with the facility to utilize their expertise effectively.

Aside from field of expertise, consider a candidate's ability to work on a team, apparent interest in and commitment to the program, and capacity for looking at situations from new perspectives and for thinking creatively.

Examples of Detailed Assessment Teams:

Metal finishing department in a large defense contractor:

- Metal finishing department manager
- Process engineer responsible for metal finishing processes
 - * Facilities engineer responsible for metal finishing department
- Wastewater treatment department supervisor
- Industrial hygienist or staff environmental engineer
- Employees from the production line including custodial and maintenance departments

Small pesticide formulator:

- * Production supervisor
- Environmental engineer
- Maintenance engineer
- Employees from the production line including custodial and maintenance departments

Cyanide plating operation:

- * Environmental engineer
- Electroplating facility engineering supervisor
- Plant chemist
- Employees from the production line including custodial and maintenance departments

Large offset printing facility:

Internal assessment team

- * Environmental engineer and/or Industrial Hygienist
- Film processing supervisor
- Pressroom supervisor

Outside assessment team (possible alternative team)

- * Engineer from within establishment
- Environmental scientist
- Printing industry technical consultant
- Employees from the production line including custodial and maintenance departments

* = Recommended team leader

Box 11 gives examples of assessment teams that might be designated for facilities of various sizes and in different industries. Note that for each team, the team leader is someone who has day-to-day operations responsibility and experience.

Review Data and Sites

Numerous data sources probably exist for a given site. Many of these may have been identified during the preliminary assessment. The detailed assessment team for that site will search for additional sources of data that will be useful in studying the targeted processes, operations, or waste streams.

Site reviews supplement and explain existing data.

Site reviews should be well planned.

- **Prepare an agenda** in advance that covers all points that still require clarification. Provide staff contacts in the area being assessed with the agenda several days before the inspection and clearly explain the purpose, timing and anticipated outcomes.
- **Schedule the inspection** to coincide with the particular operation that is of interest (e.g., makeup chemical addition, bath sampling, bath dumping start-up, shutdown, etc.).
- **Monitor the operation at different times** during all shifts, and if needed, during all three shifts, especially when waste generation is highly dependent on human involvement (e.g., in painting or parts cleaning operations). Monitoring during downtime or re-tooling can identify unique waste generation not present during normal operations.
- **Interview** the operators, shift supervisors, and work leaders in the assessed area. Discuss the waste generation aspects of the operation. Note their familiarity with the impacts their operation may have on other operations (e.g. what happens to waste streams when the process drifts out of specification).
- **Photograph or videotape** the area of interest, if warranted. Pictures are valuable in the absence of plant layout drawings. Many details can be captured in pictures that otherwise could be forgotten or inaccurately recalled at a later date.
- **Observe the "housekeeping" aspects** of the operation. Check for signs of spills or leaks. Visit the maintenance shop and ask about problems in keeping the equipment leak-free. Assess the overall cleanliness of the site. Pay attention to odours and fumes.
- **Assess the organizational structure** and level of coordination of environmental activities between various departments.
- **Assess administrative controls**, such as cost accounting procedures, material purchasing procedures, and waste collection procedures.

BOX 12

However, most of their effort will be directed toward performing a thorough site review and interviewing workers. This will help them understand the data already collected and identify factors that are not well documented and for which data will need to be collected. Site review guidelines are outlined in Box 12.

The site review should not be performed perfunctorily, even though the assessment team members who are employed at the facility will all be familiar to some extent with the work-site being reviewed. Those who are not involved in the day-to-day operation in that area will see factors that otherwise would be overlooked. Furthermore, personnel assigned to that specific site will often see it in a new light when performing a pollution prevention assessment. Some of the information that can be gathered through site reviews is summarized in Box 13.

Typical questions to ask during site reviews include:

- What is the composition of the waste streams and emissions generated in the company?
- What is their quantity?
- From which Production Processes or treatments do these waste streams and emissions originate?
- Which waste materials and emissions fall under environmental regulations?
- What raw materials and input materials in the company or production process generate these waste streams and emissions?
- How much of a specific raw or input material is found in each waste stream?
- What quantity of materials are lost in the form of volatile emissions?
- How efficient is the production process and the various steps of that process?
- Are there any steps in the process we could eliminate or combine and maintain specifications?
- Are any unnecessary waste materials or emissions produced by mixing materials - which could otherwise be reused with other waste materials?
- Which good housekeeping practices are already in force in the company to limit the generation of waste materials?
- What process controls are already in use to improve process efficiency?

BOX 13

Site visits should be well-planned to ensure that maximum benefit is obtained without excessive expenditures of time. While multiple visits to check or supplement data will usually be required, good planning can minimize such repetitions. Several suggestions for preparing for site visits are given below.

Good planning is essential for efficient site reviews.

Review existing documentation, such as operators' manuals and purchasing and shipping records. This will enable the team to focus on the topics to be investigated.

Decide on data sources and collection procedures.

Decide on data collection formats to ensure that the data collection will be rigorous and compatible with the compilation and analysis stage described on the following page. In particular, it is worthwhile to predetermine the boundaries and bases for calculating the energy and material balances that will be worked out during that stage. Doing a preliminary balance during the data collection phase can help identify data gaps and determine sampling requirements. The worksheets in Appendix 3 can be used for data collection, or you may decide to customize them or create entirely new ones to conform to the nature of the specific site.

Photographs are an excellent means of capturing extensive detail quickly and accurately.

Prepare an agenda and make sure that all team members and supervisors at the site receive it in advance.

Schedule site visits by contacting the staff in the area to be visited. Ask when they will be performing the operations you are particularly interested in assessing.

Observe operations as they are actually performed by different shifts and under various circumstances. Process units may be operated differently from the methods described in their operating manuals, or the equipment may have been modified without being so documented in the flow diagrams or equipment lists.

Look at procedures as they are performed in the production environment.

Interview workers and supervisors to determine how aware they are of what wastes are generated by their operation. They may have suggestions on reducing these wastes.

Follow the process from beginning to end, from the point where input materials enter the work-site to the point where products and wastes exit. This will help identify all suspected sources of waste. Waste sources to inspect include the production process; piping; maintenance operations; storage areas for raw materials, finished product, and work-in-process. Examine housekeeping practices and the waste treatment area, as well.

Identify waste sources.

Make follow-up visits as missing or unclear data are identified during the analysis stage.

Organize and Document Process Information

Analyzing process information involves preparing material and energy balances as a means of analyzing pollution sources and opportunities for eliminating them. Such a balance is an organized system of accounting for the flow, generation, consumption, and accumulation of mass and energy in a process. In its simplest form, a material balance is drawn up according to the mass conservation principle:

A material and energy balance for a given substance will reveal quantities lost to emission or to accumulation in equipment.

$$\text{Mass in} = \text{Mass out} - \text{Generation} + \text{Consumption} + \text{Accumulation}$$

If no chemical or nuclear reactions occur and the process progresses in a steady state, the material balance for any specific compound or constituent is as follows:

$$\text{Mass in} = \text{Mass out}$$

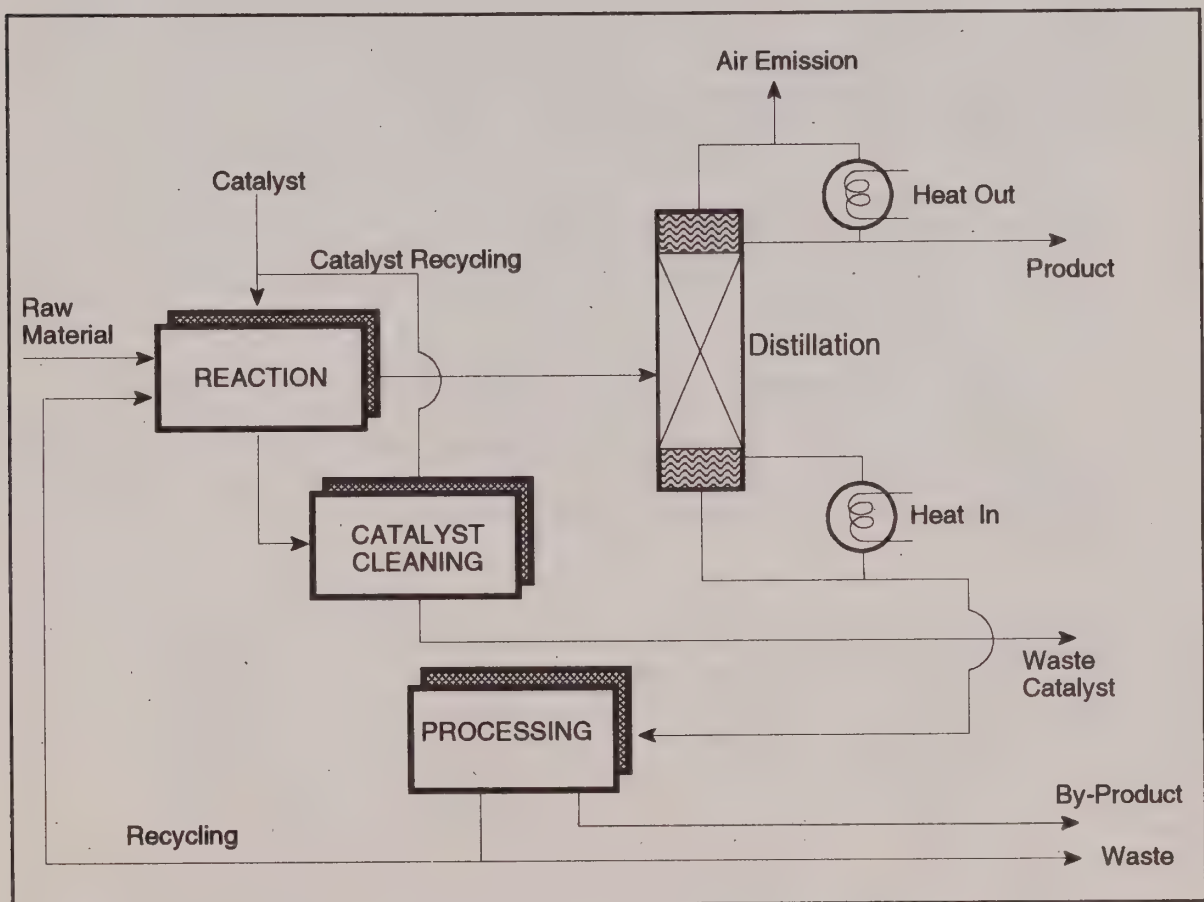


Figure 3.2 Hypothetical Process Diagram

The first step in preparing a balance is to draw a **process diagram**, which is a visual means of organizing the data on the energy and material flows and on the composition of the streams entering and leaving the system. Such a diagram shows the system boundaries, all streams entering and leaving the process, and points at which wastes are generated. An example of a flow diagram appears in Figure 3.2 .

Boundaries should be selected according to the factors that are important for measuring the type and quantity of pollution prevented, the quality of the product, and the economics of the process. The amount of material input should equal the amount exiting, corrected for accumulation and creation or destruction.

A material balance should be calculated for each component entering and leaving the process. When chemical reactions take place in a system, there is an advantage to performing the material balance on the elements involved.

The limitations of material and energy balances should be understood. They are useful for organizing and extending pollution prevention data and should be used whenever possible. However, the user should recognize that most balance diagrams will be incomplete, approximate, or both.

- Most processes have numerous process streams, many of which affect various environmental media.
- The exact composition of many streams is unknown and cannot be easily analyzed.
- Phase changes occur within the process, requiring multi-media analysis and correlation.
- Plant operations or product mix change frequently, so the material and energy flows cannot be accurately characterized by a single balance diagram.
- Many sites lack sufficient historical data to characterize all streams.

These are examples of the complexities that will recur in analyzing real world processes. Despite the limitations, material balances are essential to organize data, identify gaps, and permit estimation of missing information. They can help calculate concentrations of waste constituents where quantitative composition data are limited. They are particularly useful if there are points in the production process where it is difficult or uneconomical to collect or analyze samples. Data collection problems, such as an inaccurate reading or an unmeasured release, can be revealed when "mass in" fails to equal "mass out." Such an imbalance can also indicate that fugitive emissions are occurring. For example, solvent evaporation from a parts cleaning tank can be estimated as the difference between solvent put into the tank and solvent removed by disposal, recycling, or dragout.

DEFINE POLLUTION PREVENTION OPTIONS

Once the sources and nature of wastes generated have been described, the assessment team enters the creative phase. In a two step procedure, they will propose and then screen pollution prevention options. Their objective is to generate a comprehensive set of options, ranked as to priority, that merit detailed feasibility assessment.

Propose Options

As with other planning efforts, the best results will be achieved in an environment that encourages creativity and independent thinking by each assessment team member. Brainstorming sessions are useful for encouraging creative thought because they provide a nonjudgmental, synergistic atmosphere in which ideas can be shared. Then, these ideas can be developed by means of group decision-making techniques.

This approach will enable the assessment team to identify options that the individual members might not have come up with on their own. Worksheet 7 in Appendix 2 is a suggested format for describing each option as it is proposed.

Possible options: identify technologies, procedures, and training programs that could potentially reduce waste creation at waste creation sites/ waste streams by reducing the use of toxic chemicals through:

- substitution
- product reformulation
- production unit redesign or modification
- production unit modernization
- improved operation and maintenance of production unit equipment and methods.
- recycling, reuse, or extended use of the toxic chemical through a means that is integral to the production process.

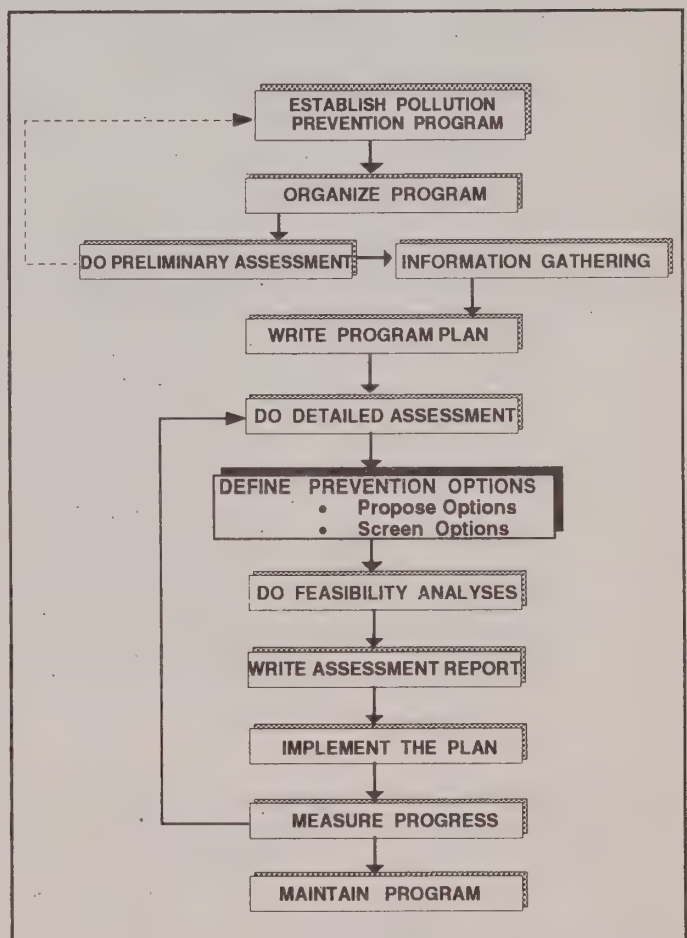


Figure 3.3 Define Pollution Prevention Options

Group the techniques for each creation site/ waste stream as follows:

- inventory management and improved operations
 - inventory and trace of all raw materials
 - purchase fewer toxic and more nontoxic production materials
 - improve material receiving, storage and handling practices
 - maintain strict preventative programs
 - implement employee training and management feedback

- equipment modifications
 - installing equipment that produces minimal or no waste
 - redesigning production lines to produce less waste
 - improving equipment operating efficiency
 - modifying equipment to enhance or permit materials recovery or recycling
 - eliminating sources of leaks or spills

- production process modifications
 - optimize reactions and materials use
 - substitute nontoxic for toxic materials
 - redesign or reformulate end products to have minimal or no toxicity
 - reduce waste generation

- recycling and reuse
 - install closed-loop systems for direct recycle
 - recycle on-site rather than off-site
 - segregate wastes by type of recovery
 - separate toxic and nontoxic wastes
 - participate in waste exchanges.

Structuring option definition sessions according to the MOE hierarchy (Chapter 1, Figure 1.1) will encourage the team to look first at true source reduction options, such as improved operating procedures and changes in technology, materials, and products. Then, options that involve reuse, or closed-loop recycling, would be examined. Finally, the team would consider off-line and off-site recycling and alternative treatment and disposal methods.

Screen Options

Many proposed options may result from the previous step. Since detailed technical, economic, and environmental feasibility analysis can be costly, the proposed options should be screened by the assessment team. Some options will be found to have no cost or risk attached; these can be implemented immediately. Others will be found to have marginal value or to be impractical; these will be dropped from further consideration. The remaining options will generally be found to require feasibility assessment.

To screen the opportunities: Decide on the screening criteria, and rank the criteria according to their importance to you. Possible screening criteria:

- waste quantity and frequency
- waste management costs (costs to handle, treat and dispose of the waste stream)
- regulatory impact
- worker health and safety risks
- pollution prevention potential with respect to speed and ease of implementation
- demonstrated effectiveness in other like facilities and industries (measure of the expected success of option).
- environmental risk impact of the chemicals present

A possible approach is to screen options first using an informal screening approach, then following up with the use of quantitative decision making tools. First conduct a preliminary screening and group as follows:

- procedural or administrative changes (these require little or no capital investment and should be implemented first):
 - segregation of processes or materials
 - changes in materials handling and inventory procedures
 - preventative maintenance
 - production scheduling
 - minor operational changes
- pollution prevention and treatment options. These require more focused and detailed evaluation using the following criteria:
 - product quality
 - worker health and safety factors
 - production constraints and flexibility
 - installation time and production downtime
 - reliability
 - commercial availability
 - proven performance in a similar application
 - permitting requirements and schedule
 - regulatory constraints
 - environmental side effects
 - expertise and skill level required for operation and maintenance

Alternative criteria include:

- pollution prevention hierarchy
- reduction of waste volume or disposal/treatment cost
- ease of implementation
- proven performance
- worker health and safety risks
- quantifiable results (economics)

The high priority pollution prevention options may be evaluated by preparing a preliminary conceptual design for each option and performing a simple economic analysis.

For capital-intensive options, the preliminary designs should include simple flow diagrams and major equipment identification and specification. Cost estimates should be prepared on published data, vendor quotes or past costing experience. Cost savings should also be estimated for the proposed options. Labour costs, waste disposal costs, production recovery costs, and utility costs are some of the elements that should be evaluated. Payback periods should be determined.

In cases where capital costs are low or not required, only annual cost savings should be estimated.

This screening does not require detailed and costly study. Screening procedures can range from an informal review with a decision made by either the program manager or a vote of the team members, to the use of quantitative decision-making tools. Box 14 shows questions to be considered in option screening.

Option screening should consider these questions:

- Which options will best achieve the goal of waste reduction?
- Are there any "early wins" available to build momentum and success?
- What are the main benefits to be gained by implementing this option (e.g., financial, compliance, liability, workplace safety, etc.)?
- Does the necessary technology exist to develop the option?
- How much does it cost? Does it appear to be cost-effective, meriting in-depth economic feasibility assessment?
- Can the option be implemented within a reasonable amount of time without disrupting production?
- Does the option have a good "track record"? If not, is there convincing evidence that the option will work as required?
- What other areas will be affected, is there a personal "ownership" issue associated with the change?

BOX 14

The informal review is a procedure by which the assessment team selects the options that appear best after discussing and examining each option. As is the case when the team is proposing options, their approach to screening should employ group decision making techniques whenever possible. In more complicated situations, the team may need to use the **weighted sum method** (see Appendix 3) or another, similar technique designed for use in complex decision-making situations.

DO FEASIBILITY ANALYSES

The final product of the option definition phase is a **prioritized list of pollution prevention options**. These options now should be examined to determine which are technically, environmentally, and economically feasible and to prioritize them for implementation.

Depending on the resources currently available, it may be necessary to postpone feasibility assessments for some options. However, all options should be evaluated eventually.

Technical Evaluation

The assessment team will perform a technical evaluation to: determine whether a proposed pollution prevention option is likely to work in a specific application. Technical evaluation for a given option may be relatively quick or it may require extensive investigation. The list in Box 15 suggests some criteria that could be used in a technical evaluation. Some of these are more detailed versions of questions asked during the option screening phase. All groups in the facility that will be affected directly if the option is adopted should contribute to the technical evaluation.

This might include people from production, maintenance, QC/QA, and purchasing. In some cases, customers may need to be consulted and their requirements verified. Prior consultation and review with these groups will ensure the viability and acceptance of an option. If the option calls for a change in production methods or input materials, carefully assess the likely effects on the quality of the final product. If after the technical evaluation the option appears impractical or can be expected to lower product quality, drop it.

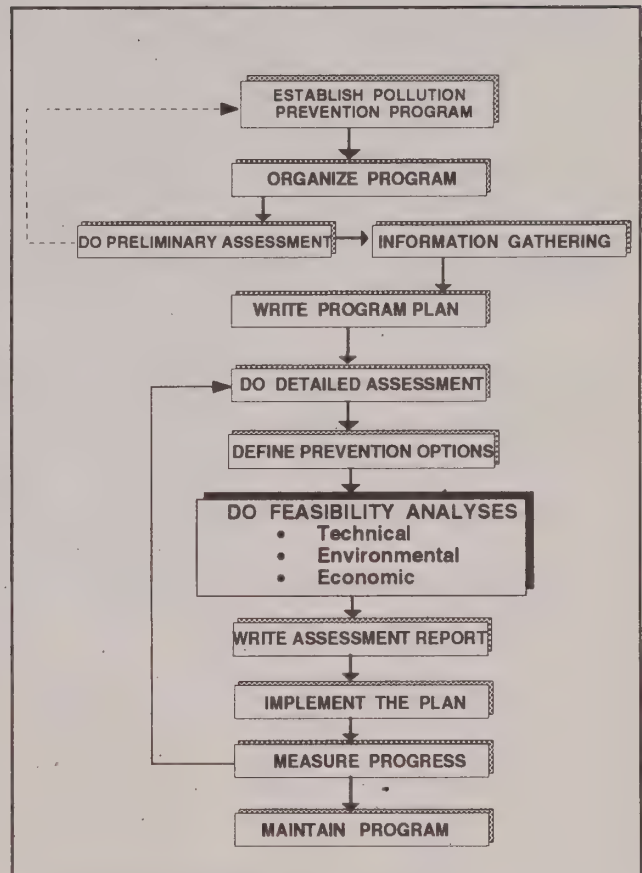


Figure 3.4 Examine Feasibility of Options

For options that do not involve a significant capital expenditure, the team can use a "fast-track" approach. For example, procedural or housekeeping changes can often be implemented quickly, after the appropriate review, approvals, and training have been accomplished. Material substitutions also can be accomplished relatively quickly if there are no major production rate, product quality, or equipment changes involved.

Equipment-related options or process changes are more expensive and may affect production rate or product quality. Therefore, such options require more study. The assessment team will want to determine whether the option will perform in the field under conditions similar to the planned application.

Options that can affect production or quality need careful study.

In some cases, they can arrange, through equipment vendors and industry contacts, visits to existing installations. Experienced operators' comments are especially important and should be compared with vendors' claims. A bench-scale or pilot-scale demonstration may be needed.

It may also be possible to obtain scale-up data using a rental test unit for bench-scale or pilot-scale experiments. Some vendors will install equipment on a trial basis, with acceptance and payment after a prescribed time, if the user is satisfied.

Typical technical evaluation criteria:

- Will it reduce waste?
- Is the system safe for our workers?
- Will our product quality be improved or maintained?
- Do we have space available in our facility?
- Are the new equipment, materials, or procedures compatible with our production operating procedures, work flow, and production rates?
- Will we need to hire additional labour to implement the option?
- Will we need to train or hire personnel with special expertise to operate or maintain the new system?
- Do we have the utilities needed to run the equipment? Or, must they be installed at increased capital cost?
- How long will production be stopped during system installation? Will the vendor provide acceptable service?
- Will the system create other environmental problems?

BOX 15

Environmental Evaluation

In this step, the pollution prevention assessment team will weigh the advantages and disadvantages of each option with regard to the environment. Often the environmental advantage is obvious --the toxicity of a waste stream will be reduced without generating a new waste stream. Most housekeeping and direct efficiency improvements have this advantage. With such options, the environmental situation in the company improves without new environmental problems arising.

Unfortunately, the environmental evaluation is not always so clear cut. Some options require a thorough environmental evaluation, especially if they involve product or process changes or the substitution of raw materials.

For example, the engine rebuilding industry is dropping solvent and alkaline cleaners to remove grease and dirt from engines prior to disassembly. Instead, they are using high-temperature baking followed by shot blasting. This shift eliminates waste cleaner but presents a risk of atmospheric release because small quantities of components from the grease can vaporize.

To make a sound evaluation, the team should gather information on the environmental aspects of the relevant product, raw material or constituent part of the process. This information would consider the environmental effects not only of the production phase and product life cycle but also of extracting and transporting the alternative raw materials and of treating any unavoidable waste.

Energy consumption should also be considered. To make a sound choice, the evaluation should consider the entire life cycle of both the product and the production process. Energy conservation is discussed further in Chapter 8.

Economic Evaluation

Estimating the costs and benefits of some proposed pollution prevention projects is straightforward, while others prove to be complex. Despite the ease with which the cost calculations may be done for some options, it is advisable to document all that are adopted and to estimate the economic effects of each. This will help ensure that these real accomplishments of your pollution prevention program will not be overlooked when you measure the program's progress, as discussed in Chapter 4.

Environmental considerations:

- effect on number and toxicity of waste streams
- risk of transfer to other media
- environmental impact of alternate input materials
- energy consumption

Consider energy requirements.

Most accounting systems do not reveal the total costs of continuing to pollute.

If a project has no significant capital costs, the decision is relatively simple. Its profitability can be judged by whether or not it reduces operating costs and/or prevents pollution. If it does, it can be implemented quickly. Installation of flow controls and improvement of operating practices, for example, probably will not require extensive analysis before they are adopted. Worksheet 9 (in Appendix 2) can be used to document analysis of this type.

Document cost calculations so that the full benefit of the pollution prevention program can be quantified.

The economic feasibility needs to be checked and rechecked.

Projects with significant capital costs attached will require more detailed analysis. There are a number of factors that make pollution prevention costs and benefits difficult to calculate for many proposed projects. The total costs of continuing to pollute are not discernible in most corporate accounting systems. Furthermore, many of these costs are probabilistic--although the risks are real, it is difficult to predict the cost and even the occurrence date from past experience.

The long-term need to avoid the spiralling costs of waste treatment, storage, and disposal as well as future regulatory and liability entanglements are likely to be major elements of your pollution prevention project economic evaluation.

Chapter 6 provides an overview of the types of cost and benefit factors that should be examined when studying proposed pollution prevention projects. It suggests some approaches to calculating indirect and probabilistic costs so that their full impact can be included in economic feasibility assessments. It also discusses ways to track the economic effects of pollution prevention projects after they are implemented.

Total Cost Analysis is a useful mechanism for understanding the financial impact of pollution prevention projects.

WRITE THE ASSESSMENT REPORT

The task force should write a report that summarizes the results of the pollution prevention assessment at the company level. Box 16 shows the report contents. The report will provide a schedule for implementing prevention projects and will be the basis for evaluating and maintaining the pollution prevention program. It may also be needed to secure internal funding for projects that require capital investment, if the members of the pollution prevention assessment task force do not have the authority to commit funds.

You may be tempted to omit this step if your company has an owner-manager and only a few employees. A summary assessment report may not be needed to resolve pollution prevention project conflicts among different areas, and your funding approvals probably are not a formal procedure requiring cost justifications. However, an assessment report will help you focus subsequent pollution prevention efforts and will be useful as a record of what aspects of your business you examined for pollution prevention opportunities.

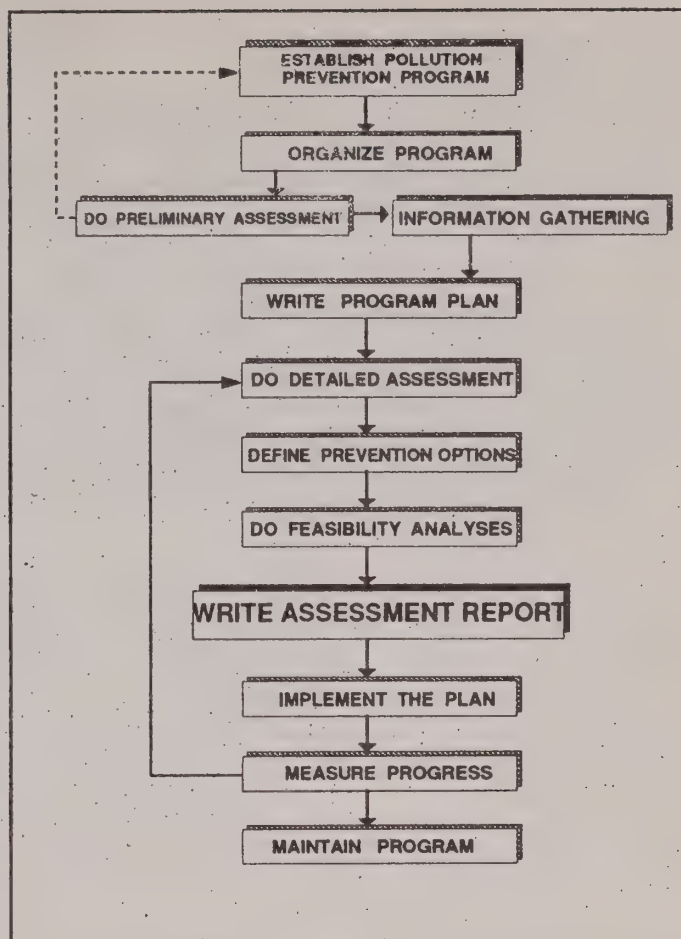


Figure 3.5 Write Assessment Report

The report on each proposed project should discuss:

- Its pollution prevention potential
- The maturity of the technology and a discussion of successful applications
- The overall project economics
- The required resources and how they will be obtained
- The estimated time for installation and startup
- Possible performance measures to allow the project to be evaluated after it is implemented

BOX 17

Input of the Assessment Teams

In a company that has several assessment teams, the task force will need to evaluate the results and resolve any conflicts that might exist among the teams as to approach and resources required for the projects they propose.

As input to this integration effort, each assessment team should prepare a summary report, presenting the results of their investigations and listing the options they screened. Each report should describe in some detail the options that the team has determined are feasible and propose a schedule for implementing them. The options recommended for immediate implementation should then be described in detail as proposed projects.

These proposals should evaluate each project under different scenarios. For example, the profitability of each could be estimated under both optimistic and pessimistic assumptions. Where appropriate, sensitivity analyses indicating the effect of key variables on profitability should be included. Each should outline a plan for adjusting and fine-tuning the initial projects as knowledge and experience increases. The proposals should include a schedule for addressing those areas and waste streams with lower priorities than the ones selected for the initial effort.

Preparing and Reviewing the Assessment Report

The task force will use the assessment teams' reports and project proposals to prepare the summary assessment report and implementation plan. The report should include a qualitative evaluation of the indirect and intangible costs and benefits to your company and employees of a pollution prevention plan. It will provide the basis for obtaining funding of pollution prevention projects. Pollution prevention projects should not be sold on their technical merits alone; a clear description of both tangible and intangible benefits can help a proposed project obtain funding.

Before the report is issued in final form, managers and other experienced people in the production units that will be affected by the proposed projects should be asked to review the report. Their review will help to ensure that the projects proposed are well defined and feasible from their perspectives. While they probably were involved in the site reviews and other early efforts of the task force, they may spot inaccuracies or misunderstandings on the part of the assessment teams that were not apparent before. In addition to ensuring the quality of the assessment report and implementation plan, this review will help ensure the support of the people who will be responsible for the success of the project.

Each assessment team summarizes:

- *results of assessment effort*
- *options proposed*
- *results of option screening*
- *results of feasibility analysis*
- *project proposal for each selected option*

Evaluate the project under various scenarios.

The summary assessment report is used for:

- *QA of implementation plan*
- *funding decisions*
- *building support for plan*

IMPLEMENT THE POLLUTION PREVENTION PLAN

Select Projects for Implementation

Final decisions on which projects will be implemented and what the schedule will be are made at this point. If the task force or company executives question aspects of some projects, the assessment teams or pollution prevention program champions may be asked to produce additional data. They should be flexible enough to develop alternatives or modifications. They should also be willing to do background and support work, and they should anticipate potential problems in implementing the options. Above all, they should keep in mind that an idea will not sell if the marketers are not convinced.

Obtain Funding

The task force will seek to secure funding for those projects that will require expenditures. There will probably be other projects, such as expanding production capacity or moving into new product lines, that will compete with the pollution prevention program for funding. If the task force is part of the overall budget decision-making procedure, it can make an informed decision that a given pollution prevention project should be implemented right away or that it can wait until the next capital budgeting period. The task force will need to ensure that the project is reconsidered at that time.

Some companies will have difficulty raising funds internally for capital investment. If this applies to your company, look to outside financing. Private sector financing includes bank loans and other conventional sources of financing. Financial institutions are becoming more cognizant of the sound business aspects of pollution prevention.

In 1989, the Bank of Boston started a unit focused strictly on environmental lending. -- Environmental Business Journal, October, 1991.

Government financing is available in some cases. It may be worthwhile to contact the Ministries of Environment; Industry, Trade & Technology or Municipal Affairs for information regarding research grants and loans for pollution prevention/ control. Appendix 5 includes a list of current provincial assistance programs and addresses where you can write for information.

Install the Selected Projects

Many pollution prevention projects will require changes in operating procedures, purchasing methods, or materials inventory control. Company policies and procedures documents and employee training will also be affected by the changes.

For projects that involve equipment modification or new equipment, the installation of a pollution prevention project is essentially the same as any other capital improvement project. The phases of the project include planning, design, procurement, construction, and operator training. As with other equipment acquisitions, it is important to get warranties from vendors prior to installation of the equipment.

Installing a pollution prevention project generally involves the same considerations as for other capital improvement projects.

Training and incentive programs may be needed to get employees used to the new pollution prevention procedures and equipment.

Review and Adjust

The pollution prevention process does not end with implementation. After the pollution prevention plan is implemented, track its effectiveness versus the claims made--technical, economic, etc. Options that do not meet your original performance expectations may require rework or modifications. Above all, reuse the knowledge gained by continuing to evaluate and fine-tune pollution prevention projects. Chapter 4 provides details on measuring progress after implementation and evaluating it against goals. Chapter 5 deals with ways to maintain and enhance a program after it is implemented.

MEASURING POLLUTION PREVENTION PROGRESS

You will want to measure your progress against your goals. By reviewing the program's successes and failures, employees and managers at all levels can assess the degree to which pollution prevention goals at the facility and production unit levels are being met and what the economic results have been. The comparison identifies pollution prevention techniques that work well and those that do not. This information will help guide future pollution prevention assessment and implementation cycles.

Quantitative evaluation also enables you to compare your unit with similar units in your company and with data from other companies. You will need this knowledge to plan enhancements of your current pollution prevention program, to select technologies for transfer from other operations, and to help identify new pollution prevention options.

ACQUIRE DATA

You will need to select a quantity (e.g., waste volume or toxicity), measure that quantity, and normalize the data as necessary to correct for factors not related to the pollution prevention method being reviewed. Although the process is simple in theory, complexities arise in practice. There are a number of factors to consider when defining what data you will track.

First, the quantity selected to track performance must accurately reflect the wastes of interest. Second, the quantity must be measurable with the resources available to you. As in the Detailed Assessment Phase, material and energy balances will be helpful in organizing data and can help fill in some gaps in data.

Useful normalization factors include:

- units produced
- hours of labour
- hours of production

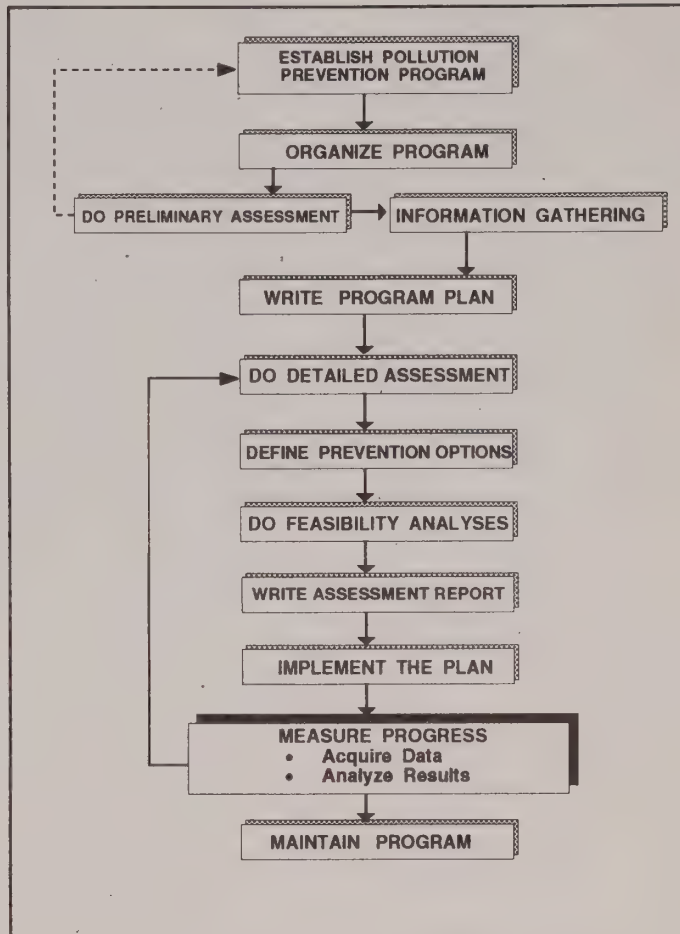


Figure 4.1 Measure Progress

After deciding what data should be tracked, you will need to determine how to collect it and what normalization may be required for each category of data.

Regulatory Reporting Data

Depending on the type of business your company engages in, you may have a considerable volume of data already collected for regulated waste streams. However, there can be gaps and discrepancies in this data. For example, MOE Hazardous Waste Legislation requires that wastes be registered and characterized by classes and total amount, but not by individual components. Therefore, this data may not be specific enough for your evaluation. In addition, accurate measuring devices may not be available for all waste streams (e.g., vaporous or fugitive emissions). In such cases, your regulatory compliance reports would have been based on estimates; comparing estimates from one period to another will not yield very reliable percent-of-change figures. Finally, year-to-year comparisons may not be meaningful if the reporting requirements changed sufficiently to cause differences in how waste quantities were measured.

It may be necessary to supplement regulatory data.

Wastes Shifted to Other Media

Transferring a given pollutant to another medium or replacing it with a different pollutant is, in principle, to be avoided. If you were to find that transfer was occurring, you would need to evaluate very carefully the relative impact on the environment. The pollution prevention option may eliminate part of the target material but shift some of it to another plant stream, to another environmental medium, or into the product.

Watch for shifts of wastes to other media.

It can be difficult to track the shift of a pollutant from one medium to another or to determine what new pollutants may be created by the new procedure.

Measuring Toxicity

The toxicity of the waste should be looked at, not just the quantity produced. Reducing the sheer volume of a given waste product while increasing its per-unit toxicity is a treatment option, but it is not pollution prevention. For example, adding lime to a waste stream to precipitate metals reduces the volume of waste but does not prevent pollution since the total quantity of metal is not changed. Since toxicity frequently is not measured as part of production reporting, you may have to establish procedures for doing so.

Toxicity measures may need to be developed.

Normalizing for External Factors

Changes in quantity are straightforward, easily understood, and is relatively easy to calculate if data are available. Quantity comparisons from one period to the next can be useful input to a pollution prevention program review. However, the data will have to be normalized if there were major factors unrelated to pollution prevention efforts that influenced the quantities produced.

There are a number of external factors that can cause the quantities and or mix of products and by-products to change. You will need to look carefully to see whether there are external factors for which you will need to normalize your data. Common ones to consider are: total hours the process operated; total employee hours; area, weight, or volume of product produced; number of batches processed; area, weight, or volume of raw material purchased; and profit from product. For continuous processes, the product output or raw material input can be a good normalization factor. Flow processes may be measured by volume or weight, whereas plating or film-making may be better normalized by area.

In batch processes, production volume usually is related to waste production, but it may not be a linear relationship in all cases. For example, the quantity of solvent used at a printing plant is primarily a function of the total volume of stock printed and ink used, but it is also significantly influenced by the number of colour changes made.

Another difficulty in comparing production and waste quantities arises when the relationship is inverse. This situation occurs frequently when the production rate decreases to the point that outdated input materials in the inventory expire. For some production processes, waste is generated during start-up and shut-down of equipment. The volume of waste created in both situations is inversely proportional to the production volume.

Revenue and profit factors can indicate the amount of activity but may not be reliable indicators if market forces often cause prices to change. Thus, monetary factors typically apply only to products in stable markets.

Establishing a Baseline

When a pollution prevention option involves incremental changes to a well-defined process, it is possible to derive a baseline from historical performance. However, directly applicable historical data would not be available for new facilities.

It may be necessary to normalize quantity comparisons to adjust for external factors.

The...system monitors rates of toxic use and waste generation...avoiding distortion of production performance due to changes in overall volume of production.

-- From an interview with Bill Schwalm on Polaroid's program, as reported in Environmental Business Journal, December, 1991.

Historical data may not be sufficient to establish baselines.

Establishing a baseline is further complicated by changes to existing processes or equipment and by new facilities that are radically different from older plants for reasons other than pollution prevention alone. In this case, the measure of success may be the amount of pollution that was never generated. Thus, a projected amount of pollution may serve as a baseline.

METHODS OF ANALYZING THE DATA

As the above discussion indicates, measuring pollution prevention progress is complex. Therefore, using a single measure to summarize pollution prevention will be applicable only in the simplest cases, if at all. The characteristics of several approaches and their advantages and disadvantages are outlined in the following paragraphs. Select the method or combination of methods that best fits your data availability, facility characteristics, and corporate goals.

Select the most useful analysis method(s) for your situation.

Semi-Quantitative Process Description

The semi-quantitative process description measurement method relies primarily on text, supplemented by a limited amount of numerical data. This type of analysis is less costly to prepare in terms of staff time and avoids many of the data collection problems discussed above. However, lack of quantitative data means that it has negligible value in evaluating achievement of specific goals. Lack of quantitative data also makes it difficult to compare similar processes when looking at potential technology transfer.

Semi-quantitative methods are easier to prepare but have less utility.

Quantity of Waste Shipped off Site or Treated on Site

Data for analysis based on transfers should be easy to obtain. Collecting such data will be among the reporting requirements of the federal NPRI starting in 1994. Quantities of hazardous waste shipped off site while still estimates, are likely to be accurately recorded in manifests making them a good starting point.

Shipping manifests and compliance reports provide data on quantities transferred.

The amounts of trash and other nonhazardous wastes can be estimated based on shipment costs and information required under provincial waste reduction regulations.

The amount of waste going to on-site waste treatment plants may be more difficult to obtain, but it should be possible to measure or estimate these quantities.

Quantity of Materials Received

Changes in the quantities of materials brought on site, as determined from receiving records, can be used to measure pollution prevention progress. Most facilities keep detailed, accurate records of material received from suppliers. These records provide a source of data to track changes in the types and volumes of materials brought into the facility. However, this method may be difficult to apply at the process or project level. In addition, the quantity input will not accurately reflect the amount of waste if some of the material is destroyed during the process or is acquired from other production units in the facility.

Quantity purchased is an imprecise measure because it does not account for loss during processing.

Quantity of Waste Generated or Used

This method is a combination of the two previous ones. It essentially gives an overall material balance for each waste component. It involves tracking the quantities of hazardous, toxic, and other materials flowing into and out of the facility. It uses data on the quantities of material purchased, produced and destroyed in the production process, and incorporated in products and by-products, as well as discharges to waste treatment and disposal.

Looking at both inputs and outputs provides a more complete understanding of progress.

This approach gives an overall picture of material use but requires extensive data collection. Data on fugitive emissions are particularly difficult to track but can sometimes be estimated by calculating material balances.

Analysis of a Process

Pollution prevention can be measured on a process-by-process basis by examining the production process in detail for changes due to pollution prevention activities. If the process is carefully selected and can be defined precisely, this approach yields an accurate description of process-related waste. It also allows better definition of a representative production or activity index for the waste generation.

Analyses based strictly on processes will overlook facility-level waste, such as lighting and construction debris.

However, it can be difficult to select which process to focus on in large facilities with complex, interconnected process units. The approach requires extensive data collection and analysis. In addition, many wastes may not be generated by a specific process. These non process-specific wastes can be missed in a strictly process-based pollution prevention measurement system. Some types of waste that can be missed include construction debris, area lighting and utility support, and plant wastewater.

Analysis of a Pollution Prevention Project

This method focuses on measuring the results of each pollution prevention activity. It is suitable for facilities that produce many products from the same production line or for facilities that have a wide variety of production processes. As with the process approach, the data requirements are extensive. It also assumes a process orientation and thus is more applicable to product or equipment changes than to behavioral changes, - such as good housekeeping or improved training.

Change in Amount of Toxic Constituents

Pollution prevention can be measured by the change in the total amounts of toxic materials released. This method, obviously, does not apply to nonhazardous wastes.

Change in Material Toxicity

Testing for and eliminating the discharge of pollutants responsible for aquatic toxicity is required under the Environmental Protection Act (EPA) and the Canadian Environmental Protection Act (CEPA).

Whole effluent toxicity testing is required under MISA regulations and as a condition of some Certificates of Approval. Standard methods are available to measure toxicity to aquatic life forms (trout, daphnia and ceriodaphnia). The source of the toxicity can be identified by more detailed testing. Process streams contributing to the plant waste effluents are sampled and, if needed, partitioned into separate phases. This detailed toxicity testing allows identification and tracking of the actual toxicity of wastes from the plant. Toxicity testing requires sophisticated testing and data handling, however, and may not be feasible for all applications.

MEASURING ECONOMIC RESULTS

Aside from assessing its effectiveness in preventing pollution, a project should be evaluated like any other new process or capital investment. Preliminary cost estimates for installing and operating the system will be made prior to installing the system. More detailed data can be collected during construction and operation. The value of reduced waste production is estimated based on volumes of waste and cost of waste treatment and disposal. The economics of the process can then be evaluated by any of several techniques such as payback period, net present value, or return on investment.

Evaluate the cost effectiveness of the program.

MAINTAINING THE POLLUTION PREVENTION PROGRAM

The task of maintaining a viable pollution prevention program will be made easier with the establishment of a **pollution prevention awareness program**. Such a program is intended to promote employee involvement in the prevention effort. The objectives of the pollution prevention awareness program are to:

- raise awareness of environment-related activities at the facility
- inform employees of specific environmental issues
- train employees in their pollution prevention responsibilities
- recognize employees for pollution prevention efforts
- encourage employees participation in pollution prevention
- publicize success stories

A review of methods for accomplishing this follows, with a summary in Box 17 on the next page.

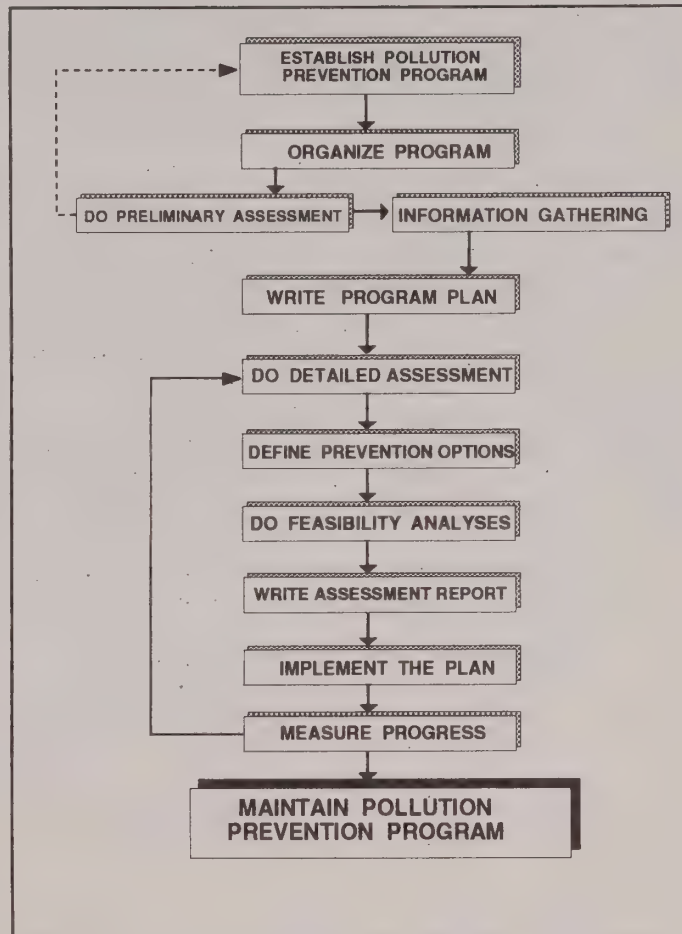


Figure 5.1 Maintain Program

INTEGRATE POLLUTION PREVENTION INTO CORPORATE PLAN

Total Quality Management (TQM)

Pollution Prevention and TQM share the core belief that if the management of the facility breaks down organizational barriers, and gives all of its employees authority and accountability, they will bring back the best possible ideas.

Pollution prevention is a multi-media activity that cuts across all environmental programs within a facility. It is essential that these programs within a facility encompass all impacts of a process or activity on air, water, waste generation and disposal, and energy use. This is more efficient from the perspective of resource allocation, on an environmental level, because facilities with multiple media impacts can be served by one effort rather than several. However, for all these efficiencies, only by bringing all employees of a facility into the loop - educating them on prevention, encouraging them to apply the principles to their work and constantly improve them, listening to their ideas will you make pollution prevention a fundamental building block in your management of the environment.

Total quality is based on the premise that to improve quality you need to change the processes that produce defects. Pollution may be fundamentally considered a proxy for waste in the production process. Changing the process with a commitment to quality can prevent the "defect" of pollution, avoiding the necessity of costly "rework" after it is created. Pollution Prevention can be part of your facility TQM system. Through: employee involvement, education and empowerment; including an iterative process of goal setting, prioritizing and implementation of options; to success stories, recognition and reporting; the TQM system forms the essential underpinnings of a successful pollution prevention program.

Key ways to maintain and improve the pollution prevention program:

Integrate pollution prevention into corporate planning:

- Assign pollution prevention accountability to the operating units where waste is generated
- Track and report program status
- Conduct an annual program evaluation at a corporate level

Provide ongoing staff education programs:

- Make pollution prevention awareness program a part of new employee orientation
- Provide advanced training
- Retrain supervisors and employees

Maintain internal communication:

- Encourage two-way communication between employees and management
- Solicit employees' pollution prevention suggestions
- Follow-up on suggestions

Reward personnel for their success in pollution prevention:

- Cite accomplishments in performance reviews
- Recognize individual and group contributions
- Grant material rewards
- Consider pollution prevention a job responsibility subject to review

Provide public outreach and education about pollution prevention efforts:

- Submit press releases on innovations to local media and to industry journals and by prospective clients.
- Arrange for employees to speak publicly about pollution prevention measures in schools and civic organizations.

BOX 17

Assign Accountability for Wastes

Operating units that generate wastes could be charged with the full costs of continuing and disposing of the wastes they generate. Cost accountability should also take into account indirect costs such as potential liability, compliance reporting, and oversight. Burying waste management costs in general overhead can lead to the illusion that disposal is "free." Allocating the costs of waste handling to the operating units that generate the waste reminds unit managers that waste control and disposal are increasingly large factors in the cost of doing business and motivates them to find ways to cease generating the waste. Chapter 6 describes several cost allocation methods.

Tracking and Reporting

Your information system should track and retain the data necessary to measure pollution prevention program results. You will need to ensure that these data are reviewed and reports prepared at meaningful intervals.

Reports should be prepared frequently enough to enable unit managers to monitor and adjust their operations to adhere to the schedule that was established during the planning stage. (See Chapter 2.) In addition, they need this information to provide feedback to their staff, as discussed below.

Annual Program Evaluation

Top management can demonstrate continuing commitment to the program by conducting annual reviews of the program. The results of these annual reviews should be communicated to all employees through written announcements and meetings. Program successes should be recognized and any changes in objectives or policies announced and explained.

If these company-level reviews demonstrate chronic schedule slippage, company executives and the pollution program task force should meet to reevaluate the program. Some objectives or the approach to achieving them may need to be adjusted. The purpose is to maintain the same high profile the pollution prevention program had initially.

Staff Education

One of the most important elements of the waste minimization and pollution prevention awareness program is training. The training program should include all levels of personnel within the company. The goal is to make each employee aware of waste generation, its impact on the site and the environment, and ways waste can be reduced and pollution prevented.

New Employee Orientation

A pollution prevention awareness orientation can be incorporated in the general orientation program given to all new employees. The orientation program would include the elements illustrated in Box 18.

More detailed pollution prevention training should be provided to new employees after they have been on the job for a few weeks. This training will provide them with the skills they need to participate in pollution prevention. It also emphasizes the company's commitment to prevention.

At many plants, employees in certain jobs must be trained and examined on their knowledge of standard operating procedures specific to the site prior to working there. Pollution prevention training can be incorporated into this. It can also be incorporated in the QA procedures qualification process.

Example of a Pollution Prevention Employee Orientation

Course: "Pollution Prevention--Description, Motivation, and Practice"

Description: This training course emphasizes your company's commitment to pollution prevention. It gives instruction and practice in techniques for promotion, persuasion, and encouragement of pollution prevention.

Goal: The goal of the training program is to explain:
What is pollution prevention?
What leads to successful implementation of pollution prevention?
What role can the individual play in promoting pollution prevention?

Lesson Plan for One-Day Orientation:

ACTIVITIES	OBJECTIVES
Get Acquainted Define Terms and Introduce Objectives Group Discussion	Outline activities Begin definition of pollution prevention as a concept and an activity Perform and discuss a pollution prevention assessment of a simple process Outline pollution prevention opportunities Analyze implementation, possible barriers and how to overcome
Hands-on Exercise (1st Half) Form Teams Individual Assigned Roles	Perform and discuss pollution prevention assessment of a complex process Experience pressures of business Experience importance of communication
Hands-on Exercise (2nd Half) Reassign Roles	Refine application Develop teamwork
Repeat Hands-on Exercise (1st Half) Discussion	Experience putting opportunities into priority list Discuss implementation, possible barriers, and how to overcome Reinforce need for pollution prevention and individual/team work. Explain significance of individual contribution to pollution prevention
BOX 18	

Advanced Training

Specialized training sessions on pollution prevention policy, procedures, and techniques should be provided to staff when their job scope is expanded or when they transfer to other areas in the company. These sessions should be considered part of the regular training program, and managers should have funds allocated to cover the costs.

If the progress of the pollution prevention program slows, review the amount and type of pollution prevention training provided and consider increasing its frequency and audience.

Retraining

Periodic retraining of employees may be necessary when your policies and procedures change. Retraining employees also will reiterate your commitment to pollution prevention.

MAINTAIN INTERNAL COMMUNICATION

Two-Way Communication

Your goal is to keep employees motivated (see Box 19). They need to identify with and "buy in" to goals and objectives and continuously have the opportunity to contribute to its success. Employees will take their pollution prevention roles more seriously when their managers keep them informed and encourage them to submit pollution prevention ideas.

Make sure employees receive regularly scheduled status reports that are clear and truthful. Objectives that are described in vague terms and have poorly quantified results and reports that are issued at odd intervals may give the impression of a reduced priority for pollution prevention. Explain to the staff any schedule slippage resulting from unexpected challenges and the need for greater staff involvement, if applicable.

Employees will work more effectively when they know what management expects of them. Cessation of reports or failure to show ongoing activities gives employees the impression that little progress is being made and/or that the overall program no longer is a priority.

Solicit and Follow up on Employees' Suggestions

Employees' ideas for pollution prevention projects should be actively sought. Employees take their pollution prevention role more seriously when management keeps them informed and encourages them to submit pollution prevention ideas. Forums such as breakfasts or informal pollution prevention review meetings promote the exchange of information that will help generate new ideas. You could run a contest to get and reward employee input. For example, you could post a checklist of pollution prevention ideas and offer cash awards for the best way to implement an idea and for the best pollution prevention idea not included on the checklist.

Suggestions should be evaluated promptly and put into practice if they are found to be feasible. Similarly, if an employee submits an idea that is not implemented, explain why it was not used and work with the employee to develop a feasible idea. Prompt feedback is necessary to maintain employee interest.

To motivate employees, managers can:

Provide feedback and reinforcement of employees' pollution prevention performance.

Set an example by adhering to the pollution prevention program and actively considering employee ideas.

Convey enthusiasm about meeting pollution prevention objectives.

When new pollution prevention measures are implemented, explain how they fit in with the overall objectives.

Regularly reinforce the importance of each individual's contributions to pollution prevention and their value to the overall objectives.

Demonstrate personal commitment to the objectives and praise the commitment demonstrated by employees.

Announce pollution prevention innovations by calling a meeting for all individuals who will be affected to discuss the change.

- Open meeting to questions and comments.
- Pay attention to signs of animosity or resistance and address these immediately.
- Gain cooperation by showing that you know and care how the employees feel.

Establish a "group identity" and work at building pride in adapting to the pollution prevention innovation.

"Go to bat" for employees who have good pollution prevention ideas that have been rejected or overlooked.

Establish quantifiable annual pollution prevention objectives:

- On a monthly basis, have employees chart their personal and the company's progress against these objectives.
- Incorporate pollution prevention goals, objectives, and accomplishments into annual job performance evaluations for people with direct process pollution prevention responsibilities.
- Readjust objectives if they prove to be unattainable.

BOX 19

EMPLOYEE REWARD PROGRAM

Performance Reviews

Progress in pollution prevention can be stated as an objective on which annual job performance evaluations are based, particularly at the management level. This delineates their responsibility for maintaining and enhancing the pollution prevention program. Using the formal mechanism of the written annual report to recognize efforts in this area raises the visibility of pollution prevention as something that is important to the company.

Recognition Among Peers

Employees who suggest pollution prevention measures that prove feasible and are slated for implementation should be publicized in the company newsletter or on bulletin boards. The estimated cost savings and/or other advantages that the company or unit will derive should be included in this announcement. Periodic group meetings may be a good forum for announcing individuals' efforts to control pollution in the company's daily operations.

Material Rewards

Cash or merchandise can be awarded to individuals. Establishing the award as a set percentage of the estimated annual savings to be realized by the company or production unit is one way to highlight the concrete value of pollution prevention.

PUBLIC OUTREACH AND EDUCATION

Employees can speak at meetings of community organizations and at schools to publicize the company's pollution prevention progress. Interviews with local media are another way to enhance corporate image and to further emphasize to employees the importance of the program.

Papers given at technical meetings and articles published in trade and professional journals are additional forms of positive publicity.

These measures all help to demonstrate that the company's commitment to pollution prevention is real.

ECONOMIC ANALYSIS OF POLLUTION PREVENTION PROJECTS

Although businesses have invested in pollution control equipment in the past for a variety of reasons, in essence, business will not voluntarily invest in such equipment unless it is seen as economically advantageous to do so.

Increasing awareness of environmental degradation and rising costs of pollution control have motivated both governments and private companies to look more closely at pollution prevention as a means of achieving environmental objectives.

The purpose of this chapter is twofold. First, the chapter suggests methods and techniques for firms to consider when evaluating pollution prevention investments. The intent is both to encourage the establishment of a consistent methodology for evaluating pollution prevention investments and to argue that, by applying the recommended techniques, readers may find it financially desirable to implement pollution prevention technologies.

Second, this chapter will outline the economic and financial analytical tools used by the Ministry of the Environment and Energy to evaluate programs and policies. By doing so, it is hoped that firms will gain an appreciation for the Ministry's point of view in developing pollution prevention planning.

The chapter is divided into the following sections. First, there is a brief discussion of pollution prevention investments and the role of financial and economic analysis. Next, the chapter then examines the economic and financial assessment tools employed by the Ministry of the Environment and Energy. The chapter then discusses some of the limitations and weaknesses associated with these assessment tools, and makes recommendations on improving these methods.

Material presented in this Chapter draws upon the experience of the Ministry of the Environment and Energy as well as relevant literature and documentation from other sources, including work done for the U.S. Environmental Protection Agency by the Tellus Institute.

Pollution Prevention Investments

The following definitions are used in this chapter:

Pollution prevention technologies and investments involve equipment primarily intended to eliminate specific contaminants from a firm's

inputs, processes and operations. Although pollution prevention investments may result in cost savings or increased revenues, they are also distinct from investments intended to increase productivity or production capacity.

Pollution abatement technologies and investments involve equipment primarily intended to reduce pollutant loadings, but which may not eliminate the contaminants altogether. Examples of pollution abatement technologies include biological, chemical or physical separation and decomposition treatment.

Pollution control refers to all pollution prevention and abatement activities.

Financial and Economic Analyses

Financial analyses refer to assessments of the financial consequences of a proposed investment *from the point of view of the person or firm which makes the investment and incurs the capital and operating costs*. This analysis is traditionally undertaken by examining the effects on cash-flow for the firm. Since firm's are seeking to maximize firm value (and shareholder returns) the investments are usually undertaken to minimize costs or maximize revenues and profits for the firm.

Economic analyses extend the financial assessment to consider the effects of investments *from the point of view of society as a whole*. In addition to estimating the incremental costs and revenues accruing directly to the firm as a result of the investment, economic analyses also identifies and explicitly considers the consequences of an investment for all individuals and firms who are not directly incorporate into the firm's analysis and who have no influence over the firm's investment decisions.

Economic Analyses -

Assessments of financial and economic effects of investments from the point of view of society as a whole.

Financial Analyses -

Assessments of financial implications of investments from the point of view of those individuals, firms and public sector agencies who incur investment costs; A subset of an economic analysis.

Financial and Economic Assessment Tools Used by the Ministry of Environment and Energy

This section of the chapter will discuss the financial and economic assessment tools used by the Ministry of the Environment and Energy. The section will begin by briefly discussing the main method used by both private firms and public sector agencies to evaluate projects: benefit-cost analysis. The section will then examine three areas which have been used extensively by the Ministry of the Environment and Energy: construction of abatement cost functions, cost-effectiveness analysis, and financial effects assessment. The section will conclude with a discuss of two other issues often examined by the ministry: community impacts and macro-economic impacts.

Economic and financial analysis procedures and techniques for evaluating potential regulatory costs are also discussed in the **Report of the Issue Resolution Committee on Economic Achievability** (1990). Examples of the application of these techniques for industrial wastewater effluent limits are found in the reports, **Economic Assessment of Water Pollution Abatement Options for Ontario Petroleum Refineries** (1992) and **Economic Assessment of Water Pollution Abatement Options for the Pulp and Paper Industry** (1993). MOEE Policy # 02-01 (**Guidelines for Economic Analyses of Private Sector Pollution Abatement and Environmental Protection Measures**, 1988), details how assessments may be initiated, what information is required and whether they might be carried out by Ministry staff or consultants.

The underlying basis for benefit-cost analyses, cost-effectiveness and abatement cost functions is efficiency. These tools and the decision rules associated with them are intended to help allocate resources and inputs so as to achieve the greatest quantity or value of benefits possible, given available resources.

1. Benefit-Cost Analysis

Benefit-Cost Analysis (BCA) has been used extensively for many years by both the private and public sector.

In the public sector, benefit-cost analysis is an analytical tool often used to evaluate the economic feasibility for projects or programs and to assist in the development of regulations, provide potential alternatives to project plans and to eliminate options which are not cost-effective.

Private-sector firms have also applied the same principles when they employ capital budgeting procedures to evaluate proposed capital investments. In these assessments, firms compare the capital and operating costs of each proposed investment with the expected revenues and other benefits, to determine the potential profit or financial return in terms of net cash flows over the period of analysis. Firms conduct such analysis taking into account factors such as the firm's cost of capital, their target internal rate of return, any uncertainty surrounding future cash flows, and the overall sensitivity of the project to changes in market conditions.

The results from using BCA to analyse the impacts of a pollution abatement investment may differ depending on both the type of investment and its size. For example, a firm may be faced with choosing among mutually exclusive pollution abatement projects. At the same time, the firm will also be seeking to maximize the value of any of these investments (or in the case of pollution abatement investments - minimize costs) by choosing a scale of each particular investment that is the most cost effective, while meeting pollution abatement or reduction requirements.

Economic and Financial Assessment Tools and Procedures:

- *Benefit-Cost Analysis*
- *Abatement Cost Functions*
- *Cost-Effectiveness Analysis*
- *Financial Effects Analysis*
- *Community Impacts Analysis*
- *Macro-Economic Analysis*

Whether analyses are being conducted by public or private agencies, benefit-cost must also consider a wide variety of intangible, non-cash effects and consequences.

Public sector benefit-cost analyses of pollution prevention and abatement projects include **damages** such as health effects, reduced crop production and degradation of aquatic life, all which may accrue to third parties. These consequences are generally not realized as costs by the sources of pollution by the emitters: industrial plants, automobile owners, individual householders, and such effects are often not explicitly considered in operational or investment decision-making by private firms, individuals and even public sector agencies. As a result, government regulation is often required to restrict activities and actions that cause pollution or can otherwise damage the environment.

At the same time, intangible **benefits** resulting from capital investments must also be included. This encompasses increased reliability of operations, enhanced good will, greater flexibility in operations, compliance with legal regulatory requirements and reduced liability. To the extent possible, these effects should also be quantified and valued in order to include them in evaluations. For example, see **United States Environmental Protection Agency, EPA's Use of Benefit-Cost Analysis: 1981-1986** (1987).

In summary, a variety of decision rules may be used with benefit-cost analyses. Firm's may:

- 1) accept all projects where the Profitability Ratio, ie. the ratio of the net present value of benefits to costs (ie. \$ benefits/\$ costs) is positive.
- 2) accept all projects where the value of benefits exceed costs.
- 3) rank potential projects according to the value of net benefits and accept all projects for which sufficient investment funds are available.
- 4) accept only projects where the expected rate of return (annual profit/total capital investment) is greater than a target rate of return (eg. interest rates earned on alternative investments or securities, after accounting for tax implications).

2. Abatement Cost Functions

Abatement cost functions have been used extensively by the Ministry for many years. In essence, the abatement cost function shows the relationship between the cost of reducing pollution and the amount of pollution reduced. An example of an abatement cost function is shown in the following graph.

Costs used in Abatement Cost Functions consist of either:

the annualized capital cost plus an annual operating cost, or

the sum, over a predefined planning period (eg. 10 - 20 years), of the net present value of total capital costs plus annual operating costs.

Abatement cost functions show the least cost combinations of technologies available to achieve specific degrees of contaminant reduction or removal. They are intended to show the full range of technological possibilities for the reduction of different types of contaminants from defined sources. Technical options with a substantial cost for the firm (in this case, Option 5) are not excluded from the abatement cost function.

The two extreme points on an abatement cost function are:

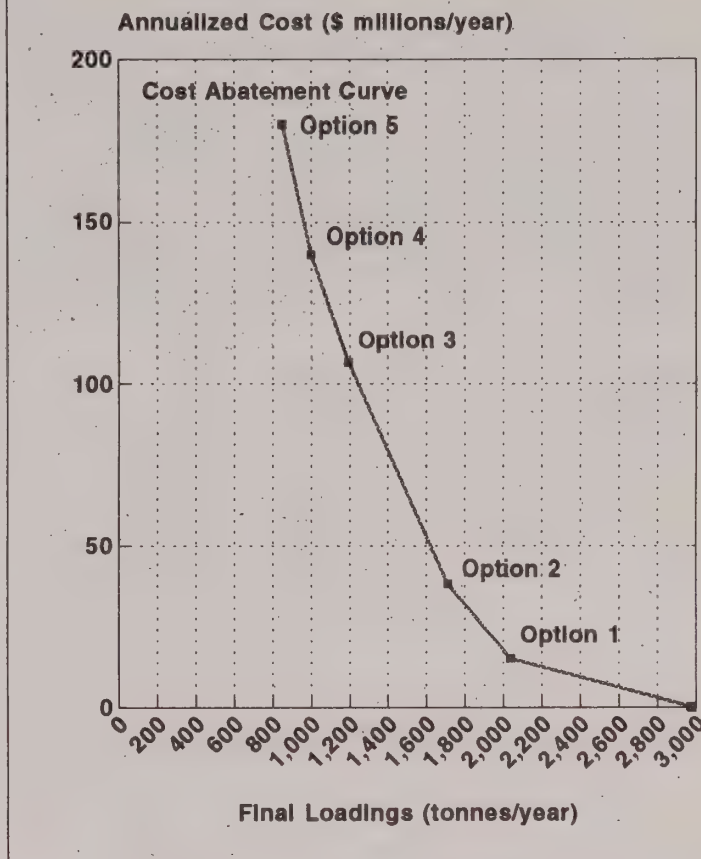
- (1) The "initial loadings" of contaminants to be reduced. This is the current loadings for the firm, without any additional costs.
- (2) The "maximum technically achievable" degree of contaminant removal possible (in the above example, Option 5). This would be the highest cost option for removal of loadings. The "maximum technically achievable" level of removal provides a useful benchmark against which lesser levels of pollutant reduction may be compared.

3. Cost-Effectiveness Analysis

Cost-effectiveness analysis can be used to identify the lowest cost to achieve a specific objective or result.

A widely used measure of cost-effectiveness is the total cost of the pollution prevention or abatement program divided by the total reduction in contaminant (or aggregation of contaminants) removed. This calculation gives an average cost per unit (usually kilogram or tonne) of contaminant removed and can be defined as follows:

ABATEMENT COST FUNCTION



$$(1) \quad \text{Average cost} = (\$/\text{tonne}) = TC_1 / TUCR_1$$

where TC_1 = Total Cost of Program 1,
(annualized cost or net
present value), and
 $TUCR_1$ = Total Units of Contaminant
Removed with Program 1

Another measure of cost-effectiveness is the **incremental cost per incremental unit of pollutant removed**, calculated by moving from one pollution prevention or abatement technology program to another and measuring the change in costs. This calculation gives a marginal cost per unit (usually kilogram or tonne) of contaminant removed and can be defined as:

$$(2) \quad \text{Marginal cost per unit} = (\Delta\$/\Delta\text{tonne}) = (TC_2 - TC_1) / (TUCR_2 - TUCR_1)$$

where: TC_1 = the total cost of Program 1.
 TC_2 = the total cost of Program 2.
 $TUCR_1$ = the total units of contaminant
removed under Program 1.
 $TUCR_2$ = the total units of contaminant
removed under Program 2.

These two ratios may be computed at any point on an abatement cost function. The point on the cost function at which the average cost (\$/tonne) or the marginal cost ($\Delta\$/\Delta\text{tonne}$) ratios are the lowest is the most cost-effective option among least cost programs.

Cost-effectiveness can be used as a decision rule for setting regulatory objectives or limits. For example, given a range of technology combinations as expressed in an abatement cost function, the option which is most cost-effective (ie. the lowest \$/tonne or $\Delta\$/\Delta\text{tonne}$ contaminants reduced) can be used as a **starting point** for developing final loading limits or contaminant reduction objectives for specific plants.

Private firms can also use cost-effectiveness analysis as a decision rule for choosing among a variety of methods or technology combinations to achieve a specific objective. Businesses can use abatement cost functions and cost-effectiveness analysis to investigate how proposed pollution prevention or pollution abatement investments might affect the **productivity** of a firm or a plant. (Productivity is measured as the quantity or value of **product** (output) per unit of input.) The extra inputs needed to compute changes in productivity can be derived from abatement cost functions. Cost-effectiveness analysis can also be used to pin-point the technology combination or investment program that could have the least effect on the productivity of a plant or firm.

Examples of cost-effectiveness analyses can be found in the report, **Economic Assessment of Water Pollution Abatement Options for the Pulp and Paper Industry** (1993).

4. Financial Effects Assessments

Once the abatement cost functions and the cost-effectiveness of the proposed pollution abatement option have been specified, firms can then proceed to analyse the impact of combinations of pollution control technology on the financial position of the firm.

There are numerous indicators that can be used when conducting financial assessments. Some of the key ratios are:

- cash-flow to debt
- total debt to total assets
- return on capital employed (earnings less taxes and payments to bondholders divided by firm value)

Efforts have been made to define indicators which are the most useful in predicting whether the additional costs of pollution control will cause a plant to be closed, employees to be laid off or a firm to be forced into bankruptcy, but with little success. KPMG Peat Marwick Stevenson & Kellogg (1990) reported that the U. S. Environmental Protection Agency (US EPA) has sponsored research to determine which financial indicators or ratios were the best predictors of single-plant company bankruptcies in the U.S. Three ratios were identified (return on assets, total debt to total assets and cash flow to total debt) but researchers could not pin-point specific universal threshold values below (or above) which bankruptcy and closure was a certainty.

Based on financial effects analyses carried out by the Ministry of the Environment and Energy, the following procedure is recommended:

1. Define an appropriate set of financial indicators for the industries or firms under investigation,
2. Calculate these indicators with and without compliance costs. (Appropriate time framer for calculation are the firm's average performance over the past 10 years, its best year, its worst year and its most recent year.) Compute these indicators with procedures and data that are agreed to by all stakeholders,
3. Stakeholders can then form their own judgements as to the severity of the financial effects and the reactions of the firm and industry which incur these costs. The results can then used as a guide to the overall impact of the pollution control investment.

Determination of the effects of pollution prevention and abatement costs on the **competitiveness** of the firm is another important, but elusive, objective of financial effects analyses. Measures of competitiveness include:

- Productivity of the firm relative to an industry average.

- Productivity of the industry relative to other sectors.

- Capacity utilization rates in the firm and industry.

- Cost-structure of both the firm and the industry.

- Ability of the firm and industry to pass on price increases.

- Ability of the firm and industry to influence input costs.

As with productivity, different pollution control investments can enhance or hinder competitiveness, depending on the technical opportunities available.

5. Community Impact Analyses

In conducting financial assessment analyses, the Ministry of the Environment and Energy is also interested in the impacts of environmental control measures on particular communities.

Indicators of interest, which focus on the community, are employment, income and expenditure.

In a market economy, one firm's cost is another's revenue. Pollution prevention and pollution abatement investments and operating expenses become income to the firms that supply goods and services for environmental protection. Governments are interested in knowing whether pollution prevention or abatement investments will be spent in the local community, in a particular region, or within the province. Governments are also interested in the level of employment in particular locations or industries such expenditures might support.

If added regulatory costs force complete or partial closures of regulated plants, job losses could result. However, as long as firms comply with environmental protection requirements without closing any operations, pollution prevention or abatement investments will generate some additional employment, even if it is only temporary while facilities and equipment are constructed and installed.

At a minimum, cost estimates should be disaggregated by the following categories so as to permit assessment of community impacts:

One-Time Capital Costs

- Engineering and Design,
- Buildings
- Equipment, Machinery and Instrumentation
- Construction and Installation.

Other One-Time Costs

- Feasibility Studies
- Regulatory Approval Fees and Applications
- Lost Revenues from Downtime during Installation

Recurring Operating Costs

- Labour
- Raw Materials
- Energy and Utilities and Waste Disposal

6. Macro-Economic Effects and Implications

Macro-economics refers to the study of the economy of a large economic region; for example, a province or a country. Macro-economics pays close attention to indicators such as consumption, investment, government spending, exports and imports. The impacts of unemployment and inflation are often also studied.

Macro-economic models have been used by the government and large firms and institutions to forecast economic growth. However, the models can also be used to evaluate the effects of policies which impose pollution control expenditures on firms and sectors. Input-output analysis, is a specific type of macro-economic tool, can be used to determine how a change in final demand for certain goods and services might affect other, inter-related industrial sectors in the economy.

Empirical assessments using input-output and other macro-economic models indicate that the total expenditures for pollution prevention or abatement must be above certain levels before these costs are likely to cause detectable effects in the economy. In essence, pollution control expenditures represent a very small fraction of total expenditures in the economy, with correspondingly negligible impacts on overall economic activity. The government, however, continues to use these tools when determining the impact of pollution control expenditures.

This section of the chapter has discussed six economic and financial assessment tools and procedures used by both the private and public sector.

Limitations and Weaknesses Associated with Prevailing Financial and Economic Assessments

Developing abatement cost functions, calculating the cost effectiveness of technology combinations and evaluating the financial effects on a firm, requires an understanding of the limitations and weaknesses associated with financial and economic assessments.

These limitations and deficiencies are discussed in the following section. The section also provides recommendations on improving the accuracy of evaluating pollution control investments.

1. Too few combinations of pollution prevention technologies are identified and estimated.

In order to calculate a cost abatement function, the firm or agency must be able to plot the relationship between several cost options and commensurate levels of pollution reduction.

In many cases, however, too few potential pollution control technologies are identified and estimated so as to derive a useful abatement cost function. The result is that it often appears that a plant or group of sources can reduce only large quantities of pollutants (at very high costs) or none at all. Alternately, certain studies indicate that only technologies which yield small reductions in contaminants are possible, implying that larger degrees of removal are not technically feasible.

MOEE experience indicates that there are usually many technology combinations that can achieve levels of contaminant removal at individual plants which exist between a low-cost and high-cost option. It is often at the intermediate levels that the most cost-effective levels of pollution abatement technology can be found.

Recommendation

Developing more options for calculating the abatement cost curve requires greater effort on the part of program proponents and the consultants who conduct the analysis. Whereas engineering consultants are most familiar with add-on, end-of-pipe pollution abatement technologies applicable to a wide variety of industrial process and waste categories, design of pollution prevention technologies and systems often requires intimate knowledge of the entire production process and system. Greater collaboration between a firm's production engineer, the environmental affairs department and the finance and budgeting departments may assist in the development of more pollution prevention options.

Limitations and Deficiencies of Financial Analyses:

Few combinations of pollution prevention technologies are identified and estimated.

Relevant cost, revenue indicators and variables may not be identified or included.

Contaminant reductions are subject to joint costs.

Time horizons may be too short.

Uncertainty of operating costs and beneficial results in pollution prevention investments not being properly recognized.

Application of different financial and economic procedures can lead to misunderstanding of overall impacts.

2. All relevant cost, revenue indicators and other variables are often not identified.

Financial assessments undertaken for pollution control investment decisions seek to minimize costs, as opposed to maximize revenue. Even when financial performance indicators of existing operations are included in the analysis, all relevant cost or revenue indicators may not be identified or properly accounted for. Examples of this are risks of liabilities associated with existing waste generation, removal and disposal, and are comprised of: penalties and fines, clean-up and remediation costs, health effects, damage to property and personal injury, and reduced final sale and salvage values.

Recommendation

Many firms do not keep separate records or data on the expenses associated with existing environmental protection and contaminant removal activities. Assembling such data can be costly. However, such information is becoming increasingly important to corporate management.

COST COMPONENTS FOR ASSESSING POLLUTION PREVENTION INVESTMENTS

ONE-TIME COSTS

- Feasibility Studies*
- Regulatory Approval Fees and Applications*
- Capital Expenditures
 - Engineering and Design*
 - Buildings (if purchased rather than constructed)*
 - Equipment, Machinery and Instrumentation*
 - Utility Connections
 - Construction and Installation*
- Lost Revenues from Down-time during Installation.

RECURRING (ANNUAL) EXPENSES

- Operation and Maintenance
 - Labour*
 - Raw Materials*
 - Energy and Utilities*
 - Waste Disposal*
 - Regulatory Compliance
 - Monitoring*
 - Record-keeping and Reporting
 - Overhead
 - Insurance
 - Workman's Compensation
 - Administration
- * Priority cost components that should be estimated or collected.

BOX 20

An inventory of **cost components** is listed in Box 20. Inclusion of these components is recommended to ensure that financial assessments are comprehensive and comparable. Those cost components marked with an asterisk (*) indicate priority cost indicators which should be estimated or collected at a minimum for any given analysis.

The inventory of **beneficial consequences** in Box 21 should also be examined and estimated with respect to each pollution prevention investment.

Add-on pollution abatement systems and technologies can often be installed more or less independently of production processes, with little interruption of output. Where pollution prevention investments involve changes in production process and inputs, manufacturing output and sales may be disrupted with some loss in revenues. On the other hand, these types of costs may be avoided by building up sufficient inventory to cover the installation period.

Overhead costs are often hidden in the sense that they are not allocated to specific processes or activities. Instead, costs are lumped together along with other common corporate costs that are difficult to apply to specific processes, activities or products. Rather than simply dividing total overhead costs incurred in a given time period by the total output or by a quantity that represents activities to which costs are to be allocated, more accurate allocation of overhead costs to production can be accomplished in at least two ways:

- 1) Detailed accounting audits may be conducted to determine how much of each overhead cost element should be assigned to specific activities in the plant. This approach may be applied once to develop "rules of thumb" or it may be repeated periodically to confirm or re-estimate cost allocation coefficients.
- 2) Define departments or "cost centres" in a firm or plant which will buy and sell goods and services from each other. Each division or group would be forced to fully document and enumerate their costs.

The most appropriate approach for an individual firm depends on its fundamental organization and the perceived need to differentiate overhead costs. For some firms or agencies, overhead cost allocation may not be worth the effort.

POTENTIAL BENEFITS OF POLLUTION PREVENTION INVESTMENTS

REDUCED INPUT COST COMPONENTS*

- Improved efficiency of operations.

INCREASED REVENUES

- Value of recovered materials*.
- Increased product quality.
- Higher final sale or salvage value of equipment.

REDUCED LIABILITY COSTS

- Reduction in fines*.
- Improvement in health.
- Reduced clean-up and remediation*.
- Reduced property damage.

PUBLIC RELATIONS

- Improved company and product image.

BOX 21

Liability "costs" noted in Box 21 are often highly uncertain values. Consequently, there is considerable uncertainty as to the benefits associated with potential pollution prevention investments. Nevertheless, taking steps to reduce risks and probabilities of liabilities is becoming increasingly important as legal liability standards become more widespread. For example, firms have successfully marketed their products as "Green" after removing certain constituents that became problematic contaminants after the product was consumed or discarded. The removal or reduction of phosphorus from detergents and lead from gasoline are prime examples of this approach.

Given the uncertain nature of some of the benefit categories and the difficulty in attributing monetary values to them, efforts should be devoted to compiling evidence as to whether or not these benefits can be realised.

3. Contaminant reductions are subject to joint costs.

Where many different contaminants are reduced or removed at the same time by certain technologies, these contaminants are said to have joint costs. Allocation of joint removal costs to specific contaminants is sometimes necessary. Conventions for allocating joint costs to each contaminant must be developed.

Recommendation

If cost-effectiveness analyses of pollution prevention options are to be conducted, then all contaminants reduced must be added to obtain values to compute cost per unit removal ratios. Some environmental professionals argue that it is not appropriate to sum contaminant loadings (see **Economic Assessment of Water Pollution Abatement Options for the Pulp and Paper Industry**, 1993). If those conducting cost-effectiveness assessments agree with this position, they will have to allocate joint costs to each pollutant that is reduced or removed.

The simplest approach is to disaggregate joint costs in proportion to the quantity of pollutants reduced. For example, if a pollution prevention program annually eliminates **X** tonnes of contaminant A and **Y** tonnes of contaminant B, at a total annualized cost of **\$Z**, the cost allocation for contaminant A is calculated as follows:

$$\text{Cost allocation for A} = \frac{X_{\text{tonnes}}}{X_{\text{tonnes}} + Y_{\text{tonnes}}} (\$Z)$$

4. Time horizons used in analyses may be too short.

Financial assessments of productivity or capacity-increasing investments apply a time frame of, at most, 3-5 years in which pay-back is expected. Much longer time horizons are required in order to realize some beneficial consequences of pollution prevention. Therefore, assessments over a longer time horizon may prove financially desirable, whereas a 3-5 year, or shorter, planning horizon span might indicate a financial loss associated with the investment.

Recommendation

As noted in the **Report of the Issue Resolution Committee on Economic Achievability** (1990), business and government representatives agreed that a minimum 10 year time horizon would be desirable for financial assessments of the effects of regulatory-induced costs on firms and industries. Since pollution prevention investments are not solely intended to earn a profit, assessments should be made over time periods longer than the 3-5 years payback period that firms expect for most investments.

Some of the benefit categories will have higher likelihoods of being realized over longer time periods, for example, reduced product liability and enhanced worker productivity. Comparisons of assessments using a 10-year time horizon and the time period that companies most generally apply would be useful.

5. **Uncertainty of operating costs and beneficial results of pollution prevention investments is not properly recognized.**

Productivity-enhancing, capacity-increasing and most pollution abatement investments generally presume a high degree of certainty about the expected technical and financial results of the project. In contrast, the operating costs and beneficial results of pollution prevention investments are often very uncertain. This uncertainty is often not properly recognized and accommodated in the financial or economic assessments.

Recommendation

There are three techniques which are widely used to determine the effects of uncertainty and risk in project appraisal.

The first technique is **sensitivity analysis** wherein values of uncertain input (or independent) variables are changed in a systematic manner. The analysis shows how varying the independent variable will cause changes in the key indicators or dependent variables. For example, if the amount of time it takes to install pollution prevention systems is uncertain, final capital costs and production disruption costs will be affected. Using plausible time periods (for example, 6 months, 1 year, 18 months, etc) in the relevant computations, the firm can determine how each of the cost categories will vary. Judgements can then be made regarding their importance to the total net costs of the potential program.

The second technique is **scenario analysis** where the decision maker considers both the sensitivity of the projects net present value to changes in key variables, but also the range of likely variable values. Often this type of analysis is done using a best-case/worst-case approach and consists of assigning **probabilities** to the potential impacts. The probabilities are then multiplied by potential financial impacts to get expected values of the project.

A third technique is **decision tree analysis**. Since many pollution abatement and prevention technologies may require capital outlays over several years, a decision tree is a useful technique, which gives managers the opportunity to adjust the pollution prevention technology combinations to minimize costs.

6. **Application of Different Analytical Techniques and Financial Measures can be Sources of Misunderstanding and Disagreement**

Firms, consultants, government agencies and academics employ a wide variety of analytical measures, conventions, investment criteria and decision rules in financial assessments. This divergence of

methods and presentation makes it difficult to compare different assessments or verify results. The use of different analytical techniques and measures are important sources of misunderstanding and disagreement.

Usually, analyses from various options must ultimately be compared or integrated with one another. In many cases, however, estimates and results from different studies are frequently not comparable or computational procedures are not transparent. Consultants frequently ask for guidance regarding computational procedures and input parameters (ie time-frame, discount or interest rates and growth or escalation rates) to be used in cost analyses.

Recommendation

A simple approach to evaluating pollution prevention investments is to add all the cost components and subtract them from all forecasted revenues, over a specific time period (eg. the life of the equipment). However, this procedure, termed payback period analysis, ignores the key issue of the "time value of money", ie. interest rates and discounting.

The following techniques are recommended:

- a. Calculation of Annualized Net Costs.
- b. Calculation of Net Present Value and Discounted Cash Flows.

If firms do not expect future cash-flows of costs or revenues change, other than by inflation, and we have a fairly large number of technical options to evaluate, the Annualized Net Cost approach is a useful technique.

If firms expect relative prices of inputs, products to change for reasons other than solely inflation and if firms have good forecasts of cash-flows, then the discounted cash flow analysis is desirable.

a. Calculation of Annualized Net Costs.

One-time costs and/or capital costs may be "annualized" and added to a typical annual recurrent net cost to obtain a typical **total annual(ized) net cost** over the time period of analysis.

A generalized annualization formula is shown in Box 22. The variables O&M and K are based on the plant specific costs incurred for the pollution prevention or abatement technology. The life of abatement equipment or system, "n", is based on the pre-specified time-frame of the analysis, usually the estimated life of the equipment. SAV is based on the estimated cost savings resulting from the decision, including if possible, an estimate of the avoided liability costs resulting from the decision. REV includes any additional revenues from sales of by-products and co-products. The discount or interest rate to be used will be discussed below.

GENERAL ANNUALIZATION FORMULAE

$$TAC = [(O\&M - SAV) \times (1-T)] + [(K \times i / (1 - (i + 1)^{-n})) \times (1 - T) - [REV \times (1 - T)]]$$

where:	TAC	=	Total Annualized Cost
	O&M	=	Operating and Maintenance Costs
	SAV	=	Cost Savings
	T	=	Income Tax Rate
	K	=	Capital Cost
	i	=	Discount or Interest Rate
	n	=	Life of Abatement Equipment or System
	REV	=	Revenues from by-product or co-product sales, etc.

When $T = 0$, TAC represents the "before-tax" net cost which is also the cost to society;

when $T > 0$, TAC represents "after-tax" cost which is borne by the polluter.

Note that the annualization formula used here is sometimes written as:

$$[r(1+r)^n] / [(1+r)^n - 1]$$

and is called a **capital recovery factor**. The two expressions are equivalent.

BOX 22

This analysis does not explicitly include an estimate of salvage value for pollution abatement capital purchases. Salvage values may be incorporated into the analysis, though for simplicity, it is assumed that such a figure would not materially affect the results given by the above equation.

b. Net Present Value Calculations

The net present value is the summation of a stream of discounted future cash flows, where the annual cash-flow (equal to O&M costs less SAV (savings) and REV (revenues) for each year) is discounted by an interest rate or discount factor. The recommended formula to calculate the net present value is shown in Box 23.

Interest rates reflect private time preferences which give more weight to the present than the future. For most private sector analyses, firms choose to use a market rate or cost of capital rate when budgeting for capital investments.

For analyses of public sector projects, however, a "social" discount rate is often used. This rate is usually lower than the market rate, and reflects the fact that in public sector analysis, greater weight is given to events that occur over a longer time horizon.

NET PRESENT VALUE CALCULATION

$$NPV = K + \text{Sum of } [V_t \times (1/(1 + i)^t)]$$

where: $V_1 \dots V_n$ = Series of annual cash flows equal to O&M - SAV - REV for each year, t, from years 1 to n.
 n = Number of years O&M, SAV and REV are estimated.
 t = The current year.
 K = Capital cost

This formulation assumes payment at the beginning of the year. If you are using Lotus, multiply the @PV function by $1 + i$.

BOX 23

While firms may find that the private benefits of pollution control and environmental protection investments are often not large enough to generate positive rates of return for the specific company using a market discount rate, but that once all costs and benefits of the investment are incorporated, and a lower discount rate is used, the investment will yield positive returns.

Summary

This chapter has provided an overview of the types of economic and financial analysis undertaken by the Ministry of the Environment and Energy, and evaluated the methods used by firms when costing the consequences of pollution prevention options.

The chapter opened by discussing the two types of pollution prevention investments and contrasted financial and economic analysis. The chapter then discussed various economic and financial assessment tools and procedures used by the Ministry of the Environment and Energy, including the issues of community impact analyses and macro-economic effects. Finally, the chapter then turned to the limitations and weaknesses of these approaches, with suggestions on improving estimation and analytical techniques.

DESIGNING ENVIRONMENTALLY COMPATIBLE PRODUCTS

Environmentally compatible products minimize the adverse effects on the environment resulting from their manufacture, use, and disposal. The environmental impact of a product is to a large extent determined during its design phase. By taking environmental considerations into account during product planning, design, and development, your company can minimize the negative impact of your products on the environment.

Design changes made to prevent pollution should be implemented in such a manner that the quality or function of the product is not affected adversely. Design for the environment can be achieved by the people directly involved, within the framework of company policy and with support from company management, whether or not in response to incentives external to the company.

The process of looking at all aspects of product design from the preparation of its input materials to the end of its use is life-cycle assessment. A life-cycle assessment of the product design evaluates the types and quantities of product inputs, such as energy, raw materials, and water, and of product outputs, such as atmospheric emissions, solid and water-borne wastes, and the end-product.

STAGES IN LIFE-CYCLE ASSESSMENT

In November 1992, the MOE sponsored its annual Technology Transfer Conference as an international pollution prevention conference on "clean" technologies and products with the theme of "Partners in Prevention". In 1990, the U.S.EPA sponsored and international pollution prevention conference on "clean" technologies and products. The introduction to the published EPA proceedings provides the following overview.

"Life-cycle assessment is a snapshot of inputs and outputs. It can be used as an objective technical tool to identify and evaluate opportunities to reduce the environmental impacts associated with a specific product, process, or activity. This tool can also be used to evaluate the effects of various resource management options designed to create sustainable systems. Life-cycle assessment takes a holistic approach by analyzing the entire life cycle encompassing extraction and processing (of) raw materials; manufacturing, transportation, and distribution; use/reuse/maintenance; recycling and composting; and final disposal".

"Socially and economically, we have been living off our capital, depleting both our resources and environment. We have all come to realize that we must at the same time compete and co-operate in a new social investment strategy that will sustain the quality of our lives without depleting our environment and resource capital."

- Hon. Ruth Grier, Minister of the Environment, speaking at the 38th Annual Ontario Waste Management Conference, June 1991.

Life-cycle assessment looks at all inputs and outputs of a product during its life cycle.

"The three components of a life-cycle assessment include (1) the identification and quantification of energy and resource use and waste emissions (inventory analysis); (2) the assessment of the consequences those wastes have on the environment (impact analysis); and (3) the evaluation and implementation of opportunities to effect environmental improvements (improvement analysis).

Life-cycle assessment is not necessarily a linear or stepwise process. Neither is it neat and tidy offering up one best solution. Rather, information from any of the components can complement information from the other two. Environmental benefits can be realized in different ways from each component of the assessment process. For example, the **inventory** alone may be used to identify opportunities for reducing emissions, energy consumption, or material use. **Impact analysis typically** identifies the activities with greater and lesser environmental effects, while the **improvement analysis** helps ensure that any potential reduction strategies are optimized and that improvement programs do not produce additional, unanticipated adverse impacts to human health and the environment."

GOALS OF PRODUCT DESIGN OR REDESIGN

When beginning to look at product design or redesign to make it environmentally compatible, the first step is to define the goals. When redesigning an existing product, goals will involve modifying those aspects of its performance that are judged environmentally unacceptable and that can be improved. Principles that should be examined include Conservation - whether it uses a scarce input material, contains hazardous substances, uses too much energy; Durability - designed for a short life/ use expectancy (planned obsolescence), not readily maintained or repaired; and Stewardship - is neither designed to be readily reused or recycled nor have safe disposal practices identified. These environmental criteria can be added to the initial program of requirements for the product, such as quality, customer acceptance, and production price.

The goals of new product design can be reformulation and a rearrangement of the products' requirements to incorporate environmental considerations. For example, the new product can be made out of renewable resources, have an energy-efficient manufacturing process, have a long life, be non-toxic and be easy to maintain, repair, reuse or recycle. In the design of a new product, these environmental considerations can become an integral part of the program of requirements.

The three phases of life-cycle analysis :

- *Inventory analysis*
- *Impact analysis*
- *Improvement analysis*

"The problem that remains following any kind of Life-cycle evaluation has to do with the environmental significance, or weighting that follows the analysis of the data. Put very simply, do you assume, that all environmental problems are of equal concern, and if you do, how do you deal with the trade-offs required when the resolution of one issue leads to the exacerbation of another? However, even with the difficulties inherent in the present state of the science of life-cycle analysis I believe you cannot have Total Quality Environmental Management without using this tool."

-Pat Delbridge, President, PDA INC. Addressing Total Quality Environmental Management Seminar, Toronto, September 23, 1992.

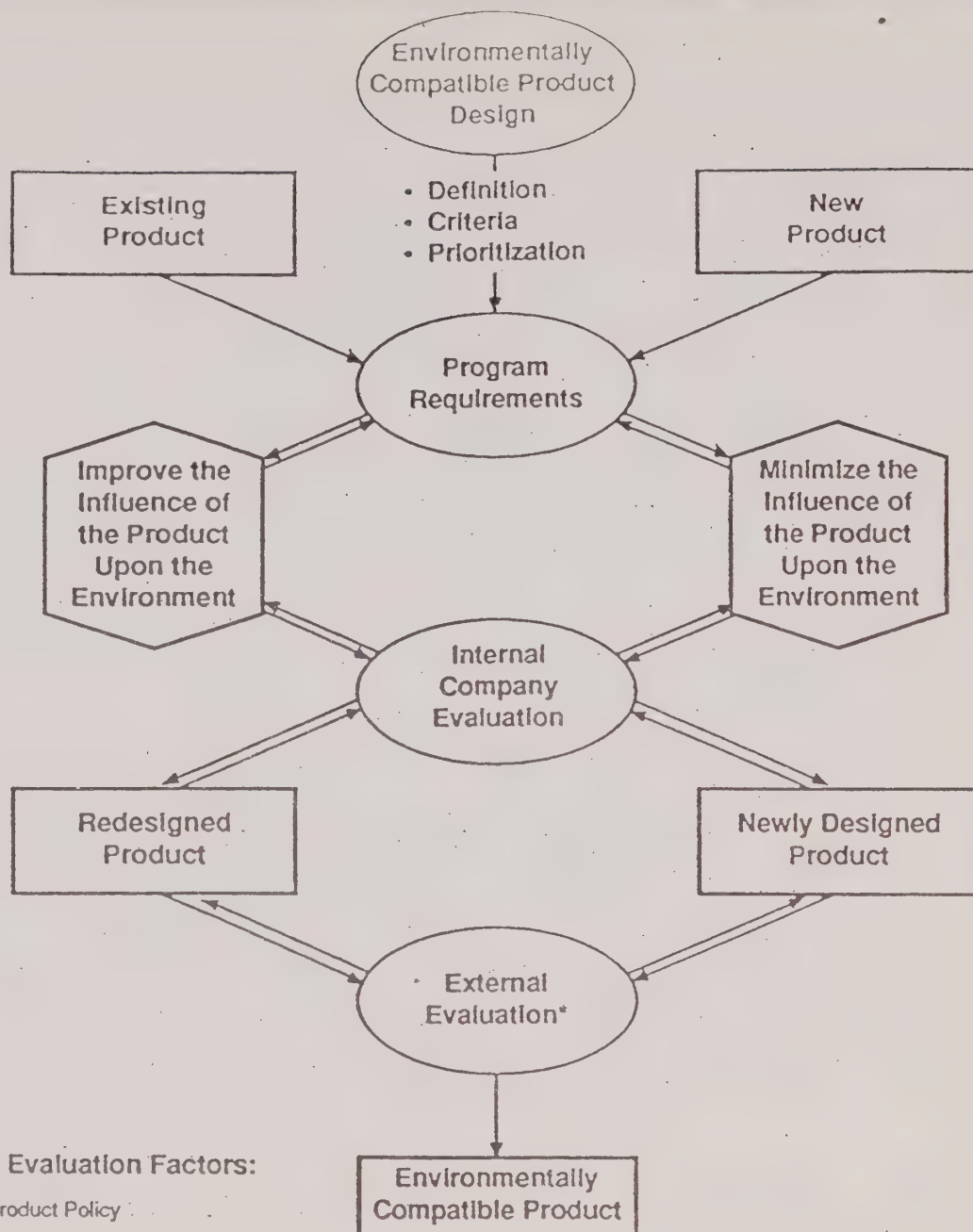
Identify the aspects of a product that have environmental impact.

There exists a range of publications and information sources on this subject. Two of particular interest are: J. C. Van Weenan's book *Waste Prevention: Theory and Practice* wherein he describes product design and redesign from the environmental impact perspective; and Braden R. Allenby's article *Design for the Environment - A New Strategy for Environmental Management* in the journal *Pollution Prevention Review*/ winter 1991-92 (See Appendix 6 for the full reference.) In both the redesign of existing products and the design of new products, the methods applied and the procedure followed will be affected by additional environmental requirements. These new environmental criteria will be added to the list of traditional criteria. Box 20 lists some environmental criteria for product design. Figure 7.1 shows a schematic representation of VanWeenan's (1990) design of environmentally compatible products.

Environmental criteria to consider in designing products:

- use renewable, natural source materials;
- use recycled materials;
- use fewer toxic solvents or replace solvents with alternative materials;
- reuse scrap and excess materials;
- use water-based inks instead of solvent based ones;
- produce combined or condensed products that require less packaging materials;
- produce fewer integrated units (i.e. more replaceable components);
- minimize product filler and packaging;
- produce more durable products;
- produce goods and packaging reusable by the consumer;
- manufacture re-cyclable final products.

Box 24



***External Evaluation Factors:**

- Product Policy
- Product Life Cycle Assessment
- Eco-Label Program
- General Perception
- Market Conditions
- Consumer Organizations
- Design Organizations

Adapted From: Dr. J. C. van Weenan, IDES, University of Amsterdam, February 18, 1991.

Figure 7-1 Schematic Representation of the "Eco-Product" Design Process

CHAPTER 8

ENERGY AND WATER EFFICIENCY AND POLLUTION PREVENTION

PREVENTING POLLUTION THROUGH ENERGY EFFICIENCY AND CONSERVATION

In June 1992, the Ministry of Energy released "A Framework for Energy Efficiency and Conservation in Ontario." The framework outlines Ontario's opportunities -- within the current recessionary economy -- for achieving greater investment in energy efficiency. As the economy improves, additional opportunities should become cost-effective and worth pursuing.

This chapter summarizes the portions of the framework that are relevant to the institutional sector. Detailed copies or summary brochures of the framework are available from the Ontario Ministry of Environment and Energy in Toronto. Telephone (416) 327-1234 locally or 1-800-ENERGY1 toll free long distance. Or write to the Ministry of Environment and Energy, 56 Wellesley Street West, 9th Floor, Toronto, Ontario M7A 2B7.

Meeting economic and environmental challenges

In an increasingly competitive marketplace, entrepreneurship and new manufacturing must be encouraged. At the same time, we must reduce the impact of energy use on the environment.

Many environmental problems we face today are a direct result of energy production and use. Emissions of carbon dioxide, nitrogen dioxide, sulphur dioxide, particulate and toxins are of particular concern because they contribute to air quality problems such as global warming, acid rain and smog.

The conventional methods of dealing with these concerns through control devices can be very costly and inefficient. Energy efficiency improvements, however, reduce emissions while cutting energy bills and creating jobs.

Energy users, customers, investors and workers all win. Using energy in the most efficient way to produce competitive goods and services is good for the economy and the environment.

Government action in its own operations

The Ontario Government is investing in energy efficiency in its own operations for three important reasons: it cuts operating costs, it shows energy users like yourself how you can participate in similar investments and it provides leadership to all sectors to join in and play a role.

Buildings A program of audits, retrofits, monitoring and energy management training will improve the energy performance of government buildings. New buildings must meet high standards of energy performance.

Fleet To reduce fuel use in its fleet, the Government has a plan that calls for reduced use of vehicles, reduced idling, driver education, purchase of smaller cars and sound record keeping.

Social housing A variety of energy efficiency initiatives in social housing will reduce energy operating costs, improve comfort and enable the Government to demonstrate cost-effective energy efficiency.

Public agencies The Government's commitment to energy management extends to public sector agencies and institutions. The Ministry of Environment and Energy provides advice on energy matters, and provides direct funding for eligible energy/water retrofits of public institutions through its Utilities Management Program.

Working together

Government action alone cannot bring about the economic savings and environmental benefits of energy efficiency. Every person and organization uses energy. Everyone -- including governments, businesses, industries, communities, institutions and individuals -- shares the responsibility for improving energy efficiency.

Incentives for achieving greater energy efficiency

The Ministry of Environment and Energy will continue to provide a wide range of programs to help energy users overcome some of the financial barriers to investment.

Financial incentives reduce payback periods for organizations and encourage cost-effective investments that might be deferred or not taken at all. To obtain information about these programs, please call 1-800-ENERGY1, the Ministry of Environment and Energy's toll free inquiries line.

Green industries strategy

Energy-efficient and more environmentally benign products and processes are already available and require only a concerted effort to accelerate their widespread adoption.

Led by the Ministry of Environment and Energy, ministries such as Industry, Trade & Technology are working with the private sector and community groups to develop globally competitive "green industries" in Ontario, providing value-added manufacturing opportunities and new, sustainable jobs.

In addition, over the next 10 years Ontario Hydro's investment in demand management initiatives could stimulate consumer purchases of several billion dollars of energy-efficient products.

Energy efficiency in transportation

Fossil fuels used in transportation are responsible for a major portion of Ontario's emissions. Cost-effective substitutes for petroleum products in transportation are, however, limited.

A "Greening of Transportation" strategy is being prepared by the Ministry of Transportation. Several other initiatives have been undertaken such as increased funding for transit/traffic management systems, education programs and urging higher fuel efficiency standards.

Price signals

Higher energy prices usually result in greater investments in efficiency and alternative energy fuels and systems. But high prices also affect consumers and businesses. Ontario's policy is to ensure fair and reasonable prices for energy consumers by encouraging competitive markets, and by using regulation where there is a natural monopoly such as in electricity and natural gas transmission and distribution.

Taxation In 1991, the Government expanded the use of existing tax incentives to encourage consumers to purchase energy-efficient vehicles. Ontario's Tax for Fuel Conservation places a surtax on fuel-inefficient vehicles and, for the first time, provides rebates for fuel-efficient vehicles.

Directions and regulations

The Government also plays an important role in ensuring that its limited resources are dedicated to services, programs and products that help to improve our energy efficiency. It accomplishes this through policy statements to ministries, government agencies and publicly funded bodies, providing consistent goals for everyone to follow.

In addition, the Government helps to protect consumers in all sectors from paying higher energy bills by restricting the sale of out-moded equipment that is not energy efficient. Regulations under the Energy Efficiency Act, the Ontario Building Code and the Plumbing Code will ensure higher energy efficiency standards.

Partnerships and you

To identify and develop opportunities in energy efficiency, the Government is encouraging individuals and groups from all sectors to work together. With the view that everyone belongs, naturally, to one partnership or another and likely even several, the Government is encouraging everyone to contribute collectively to the solution. How can you become involved? You may want to obtain more information about a program, or wish to follow up on an item in this chapter.

Your first step is to contact the Ministry of Environment and Energy. If you're in Toronto, telephone (416) 327-1234 and if you're calling long distance, dial 1-800-ENERGY1 toll free. Or, if you prefer, write to the Ontario Ministry of Environment and Energy, 56 Wellesley Street West, 9th Floor, Toronto, Ontario M7A 2B7.

Information on the following can be obtained: energy efficiency programs, technology development programs, the green industries strategy, government/public buildings programs, the Energy Efficiency Act, energy provisions of the Building Code and other regulatory directions. See Appendix 5, Technical/Financial Assistance Programs, for a list of the ministry's programs.

The Ministry of Environment and Energy want people to become more aware of how energy is used. In the end, its goal is to help people make informed choices on how to improve energy efficiency in the workplace, the community and the home.

WATER EFFICIENCY AND POLLUTION PREVENTION

Inefficient use of water results in high financial and environmental costs.

The Ontario government, led by the Ministry of Natural Resources, has developed the elements of a water efficiency strategy which could achieve zero growth by the year 2011.

These elements have been developed in cooperation with 11 other provincial Ministries and in consultation with the representatives of 95 organizations and the public.

One of the guiding principles of the strategy is that individual water users should pay in the water bill all of the costs of delivered water and treated water. Costs should not be included in realty tax bills. There is at this time some variability across the province in the cost of water as it appears on a water bill. However, one can expect to pay between \$0.70 to \$0.86 per m³ of water in urban areas. Of that cost, some 64% can be the cost for treating the water that is put down the sewer. On top of the water bill it is becoming more common to have a sewer maintenance surcharge placed on the amount of water used. This surcharge is for the replacement or up-grade of sewer and supply connections in the municipality. It is very likely that the sewage treatment portion of the water bill will continue to increase in the future in order to contend with the ever tightening water quality regulations. The efficient use of water can contribute to minimizing these costs.

In 1990, in Ontario, the water supplied by municipal water treatment plants was used as follows: the residential sector used 35%; the industrial sector used 26%; the commercial/institutional sector used 23%. About 16% (293 billion litres) was lost because of leaks.

When less water is used, water treatment plants don't have to purify and process so much of it. Less energy is needed to pump the water through the distribution system. Less water is also sent to the wastewater treatment plant.

Ways to Conserve Water

Identifying opportunities for water efficiency can be done using the same methods described for identifying sources of contaminant emissions.

You can conserve water by:

- Detecting and fixing leaks
- Conducting and acting on water audits
- Educating staff in water efficiency
- Reusing water
- Implementing water saving technology

You Can Conserve Water through:

- Leak detection programs;
- Water balancing of process using flow diagrams;
- Water efficiency education;
- Water recovery and reuse;
- Water saving technologies.

Water efficiency can lead to increased concentrations of contaminants in the wastewater, even after pollution prevention options have been instituted. This may provide opportunities for more cost effective treatment options. Regulatory movement towards loading based limits on effluent discharges will ensure that water efficiency efforts are not penalized.

APPENDIX 1

Information Gathering Environmental Issues and Your Company

This appendix is divided into three main sections: COMPANY, OFFICE-BASED and BUSINESS.

Each section contains a number of environmentally related issues that you may want to review and consider as you begin and continue your pollution prevention planning activity. There is also a blank column left for your use to enter any specific information, contacts or details you acquire through your review and information gathering steps. The three main sections and the corresponding issues identified are:

INFORMATION GATHERING - ISSUES TO ADDRESS		
COMPANY ISSUES	BUSINESS FUNCTIONS	OFFICE BASED ACTIVITIES
Environmental Policy Performance Targets Management Structure Staff Awareness & Training Public Relations Community Involvement Investment Finance/ Cost Management Legal Compliance Purchasing Policy Market Pressures Emergency/ Contingency Plans Insurance Site/ Building Management	Product Design Raw Materials Packaging Process Design/ Operations Water Use/ Discharge Energy Source/ Use Storage on Site Emissions/ Discharges Solid/ Liquid Waste Management Waste Disposal Transport & Distribution	Paper Use Equipment and Furniture Energy Waste Water

COMPANY ISSUES

<p>Environmental Policy</p> <p>Have you identified your company's environmental performance objectives? Does your company have a written policy covering the environmental implications of its activities?</p>	<p>Consider</p> <ul style="list-style-type: none"> Is the policy available to the public? Has it been circulated to the press or media? Are all employees aware of the policy and what it means to them? Your policy may appear as a separate published statement or as part of the annual report. If you don't have a policy Chapter 2 (Box4) lists some principles which may help you develop one. <p>Key Words</p> <ul style="list-style-type: none"> Environmental Auditing; Information Management 	<p>Information Resources</p>
<p>Performance Targets</p> <p>Does your company have specific performance targets relating to the environment?</p>	<p>Consider</p> <ul style="list-style-type: none"> What are the minimum standards necessary to meet legislative requirements. The regulating authorities may have their own improvement programmes. Do your environmental performance targets meet their requirements? Setting a target for improving a particular aspect of your business. This will focus the minds of all involved. Targets which you set. These should, as far as possible, be measurable in absolute terms, and relate to your company's short, medium and long term objectives. Targets should be ambitious but must be achievable. Take account of factors such as resource constraints and marketing pressures. Factors influencing your environmental performance. These will change and so targets must also be subject to periodic review. Existing legislation and trends, market pressures, public and political influence. These should all be reviewed before targets are set. <p>Key Word</p> <ul style="list-style-type: none"> Environmental Auditing 	

<p>Management Structure</p> <p>Does the organization of your company support (or inhibit) the improvement of your environmental performance?</p>	<p>Consider</p> <ul style="list-style-type: none"> • Is there a board member or senior manager with direct responsibility for environmental management? • Are staff at all levels fully aware of and responsible for the environmental implications of their actions? • Is it appropriate to set up an environment council to review your performance and to help guide policy and actions? It might include staff from each business function and perhaps representatives from outside the company. • Some central resource to monitor environmental performance, current improvement actions, legislative trends, competitor activities best available techniques. <p>Key Words</p> <ul style="list-style-type: none"> • Information Management, Site Management 	
<p>Staff Awareness and Training</p> <p>Do you encourage environmental awareness amongst your staff? Do you ensure that all staff are properly trained?</p>	<p>Consider</p> <ul style="list-style-type: none"> • Are staff given environmental objectives and responsibilities? • Are your staff encouraged to play an active role in improving the company's environmental performance (eg through "suggestion box" schemes)? • Do staff have sufficient information about the company's environmental performance, policies and plans? • Staff can be an important resource in raising your company's profile as "ambassadors" for your company. • Are all staff fully trained both for normal events and for accidents or emergencies? • Do management and staff receive training to improve their environmental awareness? • Do you mention your environmental policy, actions and performance in your recruitment literature? • Are time, money or facilities available to enable employee participation in voluntary environmental activities? <p>Key Word</p> <ul style="list-style-type: none"> • Information Management 	

<p>Public Relations</p> <p>Does your public relations department and material properly communicate your environmental performance, actions and concerns?</p>	<p>Consider</p> <ul style="list-style-type: none"> • What information can you make available to the public? Be as open as possible. • Do you have defined procedures for dealing consistently and accurately with public and press enquiries? Is the information you supply sufficiently detailed and easily understandable? • Do you disclose your company's environmental policy, targets and performance, the content and environmental impact of your product, the resources you commit to the environment? • Do you regularly communicate this information to employees, customers, suppliers, shareholders, lenders, the local community, industry bodies, environmental groups, Government, control authorities and the general public? • Could you include an environmental statement in your annual report? Could you produce a separate environmental report? • Is environmental performance likely to be an issue when recruiting new staff? • Could your packaging, vehicles or advertising carry environmental information? (Ensure that this does not make false claims about your environmental performance). <p>Key Words</p> <ul style="list-style-type: none"> • Environmental Auditing; Environmental Labelling; Information Management 	
<p>Community Involvement</p> <p>Are you involving and informing the local community?</p>	<p>Consider</p> <ul style="list-style-type: none"> • What positive environmental contributions could be made to the local community? • Have you involved yourself in the local community through contacts with schools, residents associations or voluntary organizations? • Ensuring early consultation with the local community on any new developments. • Holding open days for employee's families, schools and the public. 	

<p>Investment</p> <p>Do you take account of environmental requirements and implications in all areas of budgeting and investment?</p>	<p>Consider</p> <ul style="list-style-type: none"> Have you taken into account environmental spending in your budget plan (both in short and long term)? Do those lending you money stipulate environmental requirements? Do you carry out a due diligence review of any site or business you may be acquiring, assessing possible financial or legal liabilities relating to environmental issues? Do you take account of environmental issues when considering new investment eg in land, technology, new business areas? Is environmental performance one of your investment criteria? If you invest in other businesses, do you check or specify the environmental performance standards which they should meet? If you operate a Company Pension Scheme, have you considered how this money is invested? You may choose to invest only in companies which manage their environmental performance effectively. Have you considered sponsoring a particular environmental organization or programme? <p>Key Words</p> <ul style="list-style-type: none"> Investors/Shareholders/Lenders; Awards/Grants
<p>Finance/Cost Management</p> <p>Can you identify the financial costs associated with managing the environment and your business? Can these be reduced?</p>	<p>Consider</p> <ul style="list-style-type: none"> Are you paying unnecessary charges? For example, trade effluent charges may not account for water losses during processing. Are you able to identify all environmental expenditure? This provides useful information when communicating your environmental position It may help to have one person within the company monitor your environmental costs (eg water bills, waste disposal costs, expenditure on new environmental protection technology). Are individual departments and functions aware of the environmental costs which they incur? Could these costs be allocated directly to them? Opportunities to reduce these costs: eg by reducing or recycling the wastes which you create; or by using different waste disposal options; or local waste exchange schemes. <p>Key Words</p> <ul style="list-style-type: none"> Energy Efficiency; Environmental Taxes

Legal Compliance

Are you aware of all current legal environmental standards influencing your business? Do you monitor and seek to influence future standards? Do you have a regular dialogue with regulatory agencies?

Consider

- How do you monitor developments in legislation to ensure you are up-to-date?
- Environmental standards are now more often set by the Global Community. How do you monitor and react to these developments? Can you improve on this?
- Are you aware of the changing policies and practices within the regulatory agencies? For example, all the government agencies are under public and political pressure to enforce legislation more strongly. A regular dialogue is essential to understand how legislation is being interpreted and enforced.
- Legal controls may affect every aspect of your business, eg. labelling or products, not just the obvious areas of impact.

Key Words

- Abatement programs; Legislation; Regulations

Purchasing Policy

Do you take account of the environmental performance of suppliers of goods and services?

Consider

- Have you collected environmental information about your suppliers - their products, materials, processes and policies?
- Have you established environmental criteria for assessing your suppliers?
- How will you apply these criteria? Will you give preference to those meeting them? Will these criteria be mandatory? Over what timescale will they be introduced?
- Should you require or encourage your suppliers to carry out an environmental review of their operations?
- Can you offer financial, technical or management assistance to suppliers?

Key Word

- Environmental Labelling; Packaging

<p>Market Pressures</p> <p>Are environmental factors an influence on the market pressures relating to your goods or services?</p>	<p>Consider</p> <ul style="list-style-type: none"> • Could your sales be influenced by Green Consumerism. This term describes the increasing preference of consumers both private and commercial, to purchase more environmentally sound products, even at a higher price. • Are your customers properly informed about the environmental performance of your products? Giving misleading information may result in damaging publicity. • How can you benefit from this preference for "environmentally sound" products? • Are your products accurately labelled? • Are your competitors using their environmental performance in the marketing of their products and services? • Are any companies which you supply developing criteria for their suppliers' environmental performance? Can you meet these criteria? <p>Key Words</p> <ul style="list-style-type: none"> • Environmental Labelling; Procurement; Investors/Shareholders/Lenders; Information Management 	
<p>Emergency/Contingency Plans</p> <p>Do you have plans for dealing with emergencies or accidents?</p>	<p>Consider</p> <ul style="list-style-type: none"> • Have you identified within you business those operations which pose the greatest environmental risk? • Have you identified possible environmental effects and safeguarded against them? • Are all staff properly trained and aware of their responsibilities? • Do you have defined procedures for communicating with employees, the public and the press etc in the event of an accident? • Are emergency plans and procedures tested and upgraded when necessary? • Have you identified what might happen despite the implementation of emergency plans? • Have you studied your health and safety procedures to ensure that where practicable these do not conflict with environmental considerations? For example, washing split material down drains as quickly as possible may reduce risk to employees but may cause water pollution. <p>Key Words</p> <ul style="list-style-type: none"> • Accidents; Health and Safety; Noise; Site Management 	

Insurance

Are you properly insured for any environmental liabilities which may result from your business activities?

Consider

- Have you obtained insurance for any potential risk to property, to public health or to the environment.
- The Insurance companies may place limits on the liabilities which can be covered.
- Full environmental indemnity may be difficult to obtain. Insurance companies may require some assurance that your company is properly managing its environmental impacts.

Key Words

- Insurance

Site/Building Management

Are your business premises well maintained? Do you seek to introduce good housekeeping practices? Are noise and odour levels monitored to ensure that reasonable levels are not exceeded?

Consider

- Are building utilities properly operated, checked and maintained, particularly heating, ventilation and air condition equipment?
- Are there opportunities to landscape your site or refurbish buildings to improve the appearance and the working environment?
- Are there areas of contaminated land on your site? Can you restore these or can you minimize any impact from the contaminants?
- Have you investigated if there are awards or grants available to assist you with site improvements?
- Are waste storage facilities appropriately designed?
- Are there opportunities for you to develop the wildlife on your site? Are there ponds or hedges or areas of waste land which could be developed for this purpose?
- Could parts of your site be used for educational or public amenity purposes?
- Are any operations which cause odour or noise located on parts of the site away from likely sources of complaint?
- Are operating practices designed to keep external noise and odours to a minimum?
- The appearance of your premises is a key factor in influencing the public's and the customers perception of your business.
- An untidy site may result in unnecessary hazards to employees or the environment eg fire hazard.

Key Words

- Site Management; Awards/Grants; Noise; Environmental Impact Assessment; Other Air Pollutants

Office-Based Activities

<p>Paper Use</p> <p>Is paper used and disposed of efficiently? Do you know how much paper you use and how much it costs? Can you reduce usage and thus your costs?</p>	<p>Consider</p> <ul style="list-style-type: none"> • Can paper usage be reduced or made more efficient eg via greater use of electronic mail, voice communications or changes in general office practice? • Can more recycled paper be used in offices? • Are there opportunities to reduce costs by using recycled paper? • Have you investigated possibilities for recycling your waste paper? Would this reduce waste disposal costs? • Do you separate different types of waste paper to facilitate reuse and recycling? • How many internal and external business forms do you have? Can these be rationalized? • Could employees be encouraged to do more double-sided photocopying? • Are internal circulation lists based on a need-to-know basis, particularly where long or costly documents are concerned? <p>Key Words</p> <ul style="list-style-type: none"> • Paper; Recycling; Waste Management; Energy Efficiency
<p>Equipment and Furniture</p> <p>Have you reviewed the environmental performance of your office equipment, furnishings and other supplies? Does your purchasing policy take into account environmental considerations?</p>	<p>Consider</p> <ul style="list-style-type: none"> • Can more environmentally sound cleaning materials and methods be applied? • Is furniture made from sustainable resources avoiding tropical hardwoods? Is there scope to use recycled materials. • The environmental impact of all office equipment, materials and supplies eg photocopying inks and toners, solvent vapours, correction fluids, fluorescent lights, fire extinguishers, printing inks? <p>Key Words</p> <ul style="list-style-type: none"> • Recycling; Waste Management; Sustainable Resources; Deforestation; Health and Safety; Solvents; CFCs

Energy

Is energy used efficiently? Have measures to reduce consumption been investigated and actioned?

Consider

- Is energy usage regularly reviewed?
- Are energy efficiency practices encouraged?
- Are energy bills/usage monitored, by individual departments?
- Are buildings designed and insulated to promote energy efficiency?
- Is lighting energy efficient in design and operation? Is the use of natural light maximized?
- Are any electrical appliances which you use the most energy efficient available?
- Has the installation of integrated energy management systems been investigated? These can control heating, lighting, air conditioning and electrical loads.
- Are your transport and distribution functions efficient in their use of fuel?
- Are emissions from energy sources on site properly controlled, eg boiler houses and generators?
- Can use of energy derived from fossil fuels be reduced?
- Have alternative energy sources been reviewed, eg methane from landfill gas, refuse-derived fuel, or combined heat and power systems?

Key Words

- Energy Sources; Energy Efficiency; Global Warming; Acid Rain

Waste

Is waste of all type, paper, plastics and metals minimized? Is any residual waste recycled, reused or if this is not possible, properly disposed of? Are waste disposal costs properly controlled?

Consider

- Do you know how much waste you produce and its detailed content and source? Do you maintain records of waste production and disposal routes and costs?
- Do you segregate your waste to facilitate recycling?
- Have recycling opportunities been fully explored and utilized? How much recycling is currently carried out?
- Have you explored local waste exchange schemes? Your waste could be another company's raw material.
- Could office wastes be minimized by using less or alternative materials? eg reusable typing ribbons.
- Have domestic wastes - food waste, packaging, beverage containers - been minimized?
- Are commercial waste disposal contractors properly registered, cost efficient and environmentally responsible?
- Do contractors recycle some of your waste? If so, how much and what benefit does this give you?
- Do contractors use disposal sites which are licensed to accept your waste?
- Do contractors operating on your site dispose of waste efficiently and in an environmentally responsible manner?

Key Words

- Solid Waste

Water

Is water supply and sewage disposal efficiently managed? Is water usage monitored and controlled? Are costs controlled?

Consider

- Does drinking water quality comply with legal requirements? Is this quality monitored?
- Do you monitor water supply and sewerage costs and quantities used/discharged?
- Can usage and costs be compared across departments or sites?
- Is the water metered? Installing a meter may yield cost savings.
- Are flow meters and flow restricters appropriate to help to monitor and control consumption?
- Have all measures been used to reduce consumption eg fitting spray tap's, reducing quantities needed for showers and WCs, placing flow restricters on taps?
- Are leaking pipes quickly mended?
- Can you use recycled water instead of mains water for some services?
- Are sewer discharge costs correctly calculated? Do you ensure that no hazardous chemicals, even in small quantities, are disposed of to drain or surface water run-off?
- Are fire sprinkler systems properly maintained?

Key Words

- Water Supply; Effluent Discharge

Business Functions

Having identified the company and office-based environmental issues which will apply to almost all companies, you should now consider the other specific areas of environmental concern which relate to your business functions.

<p>Product Design</p> <p>During the design of your products, do you consider and minimize the actual and potential impacts on the environment? Do these considerations extend from supply and production through use to ultimate disposal?</p>	<p>Consider</p> <ul style="list-style-type: none"> • Are your products subject to current or proposed environmental legislation? Can you meet these legal requirements? • Are products designed to minimize the energy and raw materials required to make them? Has the potential for using recycled materials been maximized? • Can the product be designed in a way which would reduce the environmental impact of the production processes and minimize waste production? • Can product design alterations reduce the need for packaging materials? • Is the product designed to maximize its useful life and this minimize the use of resources? • Does product use result in environmental impact? Can this be minimized? • Are products designed to facilitate disposal? <p>Key Words</p> <ul style="list-style-type: none"> • Solid Waste; Energy; Environmental Labelling; Awards/Grants; Sustainable Resources

Raw Materials

Do you consider the environmental impact of obtaining and using raw materials?

Consider

- Which raw materials you use and the source of these materials? What is the environmental impact at source and during any subsequent processing?
- Does environmental legislation restrict raw materials you may use in your products?
- Have you considered alternative materials which may be less environmentally damaging or which may make the final product more environmentally sound? In particular, can your choice of raw material reduce the impact during waste disposal?
- Could recycled or recovered raw materials be used? Have you checked whether any cost reductions could be achieved by recycling materials?
- Are your suppliers of raw materials adopting sound environmental policies/practices?
- Can your raw materials be obtained from renewable resources?
- Are raw materials over-specified? Could lower grade or waste materials be used?
- Are any potentially hazardous materials used? Could these be replaced or delivered and used in ways which have a lesser impact on the environment, health and safety?

Key Words

- Recycling; Sustainable Resources; Environmental Labelling; Packaging; Waste Management

<p>Packaging</p> <p>In packaging products for transportation or sale do you seek to minimize the packaging required? Do you assist the recycling or reuse of the packaging</p>	<p>Consider</p> <ul style="list-style-type: none"> • Can packaging be reduced? Can your products be distributed and sold in bulk or loose? • Can your packaging be designed to be reused, refilled or at least recycled? • Can the materials of construction be altered to facilitate waste disposal? • Is it possible for you to encourage consumers to reuse or recycle packaging eg through bottle bank collection, the reuse of plastic bags, refillable containers etc. <p>Key Words</p> <ul style="list-style-type: none"> • Packaging; Recycling; Waste Management; Environmental Labelling 	
<p>Process Design/Operation</p> <p>Are your manufacturing processes designed and operated to minimize their environmental impact?</p>	<p>Consider</p> <ul style="list-style-type: none"> • Are processes designed to minimize energy and water usage and raw material consumption? • Do you recycle or reuse energy, water and materials where practicable? • Are appropriate environmental monitoring systems in place throughout these processes? • Is the best available technology used to prevent damage to the environment? Do you regularly review developments in technology to identify possible improvements? • Are processes designed and operated to minimize effluent, emissions and solids. • Could processes be designed to be waste-free? <p>Key Words</p> <ul style="list-style-type: none"> • Energy; Solid Waste; Atmospheric Emissions; Effluent Discharge; Awards/Grants 	

Water Use/Discharge

Do you know how much water you use? Can this be reduced? How much do you pay for water services? Can savings be made?

Do you comply with all current legal controls on planned discharges of effluent? Are you aware of future controls?

Consider

- What is your current spend on water supply and sewerage/effluent treatment?
- Is the source of your water supply being depleted by over-abstraction?
- Are all water supplies metered at each production function? Are all leakages mended quickly?
- Are alternative, cheaper sources available eg direct abstraction? Can cheaper supplies be obtained by accepting non-potable water?
- Are there opportunities to introduce or increase water or effluent recycling?
- Is effluent being disposed of efficiently and effectively? Are legislative requirements being met, both current and future?
- Is it better to treat effluent on site or via the sewerage system? Can you reduce the environmental impacts and costs perhaps by sharing treatment facilities with adjacent business?

Key Words

- Water Use; Effluent Discharges; IC

Energy Sources/Use

- Has energy consumption during production been reduced to a minimum? Are you able to use more environmentally sound sources of energy?

Consider

- Have you selected the least environmentally damaging sources of energy? There may be scope for using combined heat and power, land fill gas, solar power, waste derived fuel, wind energy and other sources.
- Have you maximized possibilities for energy recovery? For example by using heat exchangers, recirculating cool or process waters or improving plant insulation.
- Are energy usage and costs monitored and are efficiency or reduction targets set? Can this be done for individual departments?
- Are there opportunities to use high efficiency motors and variable speed drives?
- Are the factory premises designed to maximize energy efficiency? Have they been insulated?
- Could equipment be upgraded to improve energy efficiency?

Key Words

- Global Warming; Energy Sources, Energy Efficiency; Acid Rain; Environmental Taxes

<p>Storage on Site</p> <p>Are any raw materials, products or waste materials which are stored on site properly managed to minimize risk of environmental damage?</p>	<p>Consider</p> <ul style="list-style-type: none"> Do you meet any legal requirements relating to the storage of potentially hazardous materials. Are storage areas contained or banded to prevent run-off of chemicals etc. in the event of an accident or fire? Are hazardous materials kept in a secure place? Are all storage containers (eg drums, bottles) clearly and correctly labelled? Are hazardous materials handled properly during delivery and unloading? Do you have appropriate contingency plans in event of a spillage, accident or fire? <p>Key Words</p> <ul style="list-style-type: none"> Site Management; Waste Management; Accidents 	
<p>Emissions/Discharges</p> <p>Have you identified and quantified the emissions into the environment resulting from your operations? Have you taken steps to minimize them?</p> <p>Do you meet all current legal requirements? Are you aware of likely future standards?</p> <p>Have you set targets to reduce emissions and identified measures to achieve these targets?</p>	<p>Consider</p> <ul style="list-style-type: none"> Have you identified all sources of emissions to water, to air, or land? As well as any obvious sources there may be more diffuse sources such as drying or surface cleaning operations. Are you able to quantify all your emissions including any low concentration contaminants? Are you aware of their physical and chemical characteristics? Are emissions monitored and are detailed records kept? Do you have the appropriate authorizations for these emissions? Do these emissions consistently meet legal requirements? Have you reviewed developments in process and abatement technology to establish the best available techniques to minimize emissions? Reducing one form of emission may result in increases in other emissions. The overall environmental impact of any planned emission must always be fully considered. <p>Key Words</p> <ul style="list-style-type: none"> Atmospheric Emissions; Effluent Discharges; Solid Waste; Awards/Grants; Environmental Taxes 	

Solid Waste Management

Having assessed the possibilities for minimizing waste generation, are those wastes which you do create managed efficiently and safely on site? Do you comply with all existing legislation and are you aware of likely future standards?

Consider

- Do you know how much waste you produce and what it contains?
- Is there scope for recycling waste as secondary raw materials or for alternative processes? Could another company make use of your wastes?
- Do you have clear procedures for managing waste on your site? Are those staff involved in handling waste properly trained and aware of their responsibilities?
- Have you set targets to reduce the quantities of solid waste generated?
- Are recyclable and non-recyclable wastes fully segregated to facilitate recycling?
- Are wastes stored on site securely and in a manner which minimizes environmental risks? For example, are wastes correctly labelled and packaged and are waste stores suitably contained?
- Do you have defined procedures to cater for spillages of waste? Are staff trained to implement these procedures?

Key Words

- Solid Waste

Waste Disposal

Are those wastes which you do create disposed of responsibly?

Consider

- Do you keep accurate records of the wastes generated and their disposal routes?
- Have you quantified all the costs of dealing with your wastes (including storage transportation, treatment and disposal)? Do you keep a record of waste disposal costs?
- Are your wastes transported and disposed of in a manner which minimizes any environmental impact and meets all legal requirements?
- Have you analyzed all the available disposal routes? Are there special legal requirements for transporting or disposing of the types of waste which you generate?
- Are your waste disposal contractors operating in an environmentally responsible manner? Have you clearly informed the contractor of the content of your waste? Is the site chosen for disposal licensed to receive your waste?

Key Words

- Waste Management; Accidents

Transport and Distribution

Have you attempted to reduce the impact of your transport and distribution methods on the environment? Any analysis should include the distribution of supplies and raw materials, company cars and service vehicles and staff commuting.

Consider

- Do you provide company cars for your employees? Is this essential for their work?
- Are there restrictions on engine size? Do you pay private mileage or a fuel allowance? Are vehicles properly maintained?
- Could you operate a pool car system rather than providing employees with company cars?
- Do you encourage employees not to travel long distances to meetings unless it is imperative for them to attend? You could use teleconferencing or phone conferencing instead.
- Do you encourage employees to share cars on long journeys rather than drive separately?
- Are your commercial vehicles maintained regularly?
- Could you use or encourage alternative modes of transport eg rail: use of company buses/bikes? Could you discourage car use eg by imposing parking restrictions?
- Are you using the most appropriate distribution routes and methods? Are you aware of the environmental impact of these activities?
- Do you consider implications for distribution and commuting when reviewing the location of new buildings?
- Are you aware of the effects on the local community of your vehicle movements?

Key Words

- Vehicle Emissions; Energy Efficiency; Global Warming; Environmental Taxes; Accidents

APPENDIX 2

Example Planning Worksheets

The extent and complexity of the system for collecting pollution prevention data should be consistent with the needs of your company. Keep in mind that the goal of the program is to prevent pollution, not to collect data--the simplest system that fits your needs is the best. Depending on the nature and size of your firm, much of the data needed for a pollution prevention program may be collected as a normal part of plant operations or in response to existing regulatory requirements.

Appendix 2 provides some of the elements you may wish to consider. The worksheets in Appendix 2 can also be used for the pre-assessment; after which you may decide to tailor them to fit your particular situation.

Planning worksheets are included here for:

WORKSHEET 1		The Planning and Assessment Process (Overview)
WORKSHEET 2	•	Identifying your business site;
WORKSHEET 3	•	Identifying available sources of Pollution Prevention Planning information;
WORKSHEET 4	•	Summarizing Individual Process Input Materials (for Mass Balance review);
WORKSHEET 5	•	Summarizing Individual Process Output Materials including products (for Mass Balance review);
WORKSHEET 6	•	Summarizing Individual Process Waste Stream Outputs (for Mass Balance review);
WORKSHEET 7	•	Identifying and assessing your own prevention and reduction options;
WORKSHEET 8	•	Detailing individual options from above for feasibility analysis; and
WORKSHEET 9	•	Tabulating the profitability (costs and savings) of implemented projects.

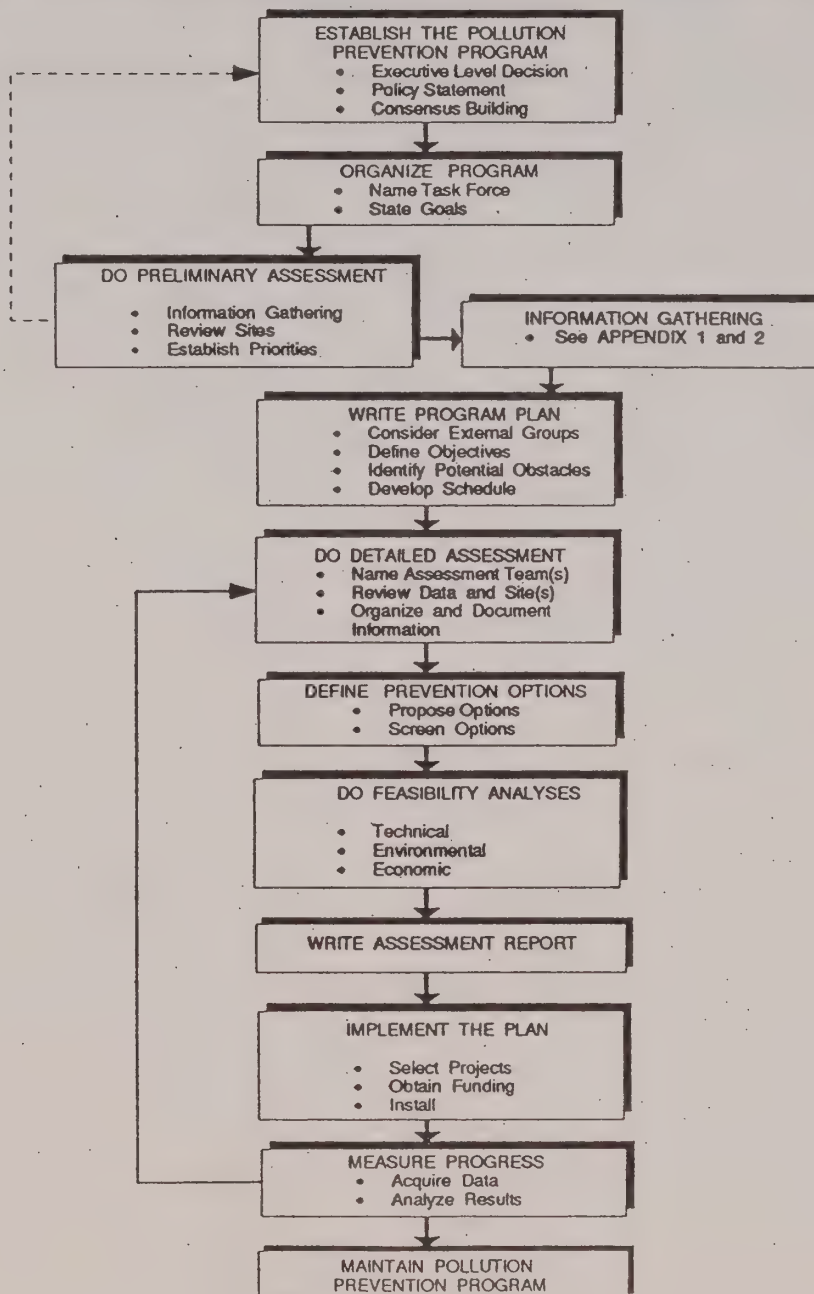
Other useful information that may assist you in evaluating priorities include those areas such as; company issues, business functions and office-based activities (See Appendix 1).

Firm _____ Site _____ Date _____	Pollution Prevention Assessment Worksheets Proj. No. _____	Prepared By _____ Checked By _____ Sheet _____ of _____ Page _____ of _____
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WORKSHEET

1

ASSESSMENT OVERVIEW



Firm _____ Site _____ Date _____	Pollution Prevention Assessment Worksheets Proj. No. _____	Prepared By _____ Checked By _____ Sheet ____ of ____ Page ____ of ____
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WORKSHEET

2

SITE DESCRIPTION

Firm: _____

Plant: _____

Department: _____

Area: _____

Street Address: _____

City: _____

State/Zip Code: _____

Telephone: () _____

Major Products: _____

SIC Codes: _____

EPA Generator Number: _____

Major Unit: _____

Product or Service: _____

Operations: _____

Facilities/Equipment Age: _____

Firm _____ Site _____ Date _____	Pollution Prevention Assessment Worksheets Proj. No. _____	Prepared By _____ Checked By _____ Sheet ___ of ___ Page ___ of ___				
<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> WORKSHEET 3 </div> <div style="text-align: center;"> PROCESS INFORMATION </div> </div>						
Process Unit/Operation: _____ Operation Type: <input type="checkbox"/> Continuous <input type="checkbox"/> Batch or Semi-Batch <input type="checkbox"/> Discrete <input type="checkbox"/> Other _____						
Document	Status					
	Complete? (Y/N)	Current? (Y/N)	Last Revision	Used in this Report (Y/N)	Document Number	Location
Process Flow Diagram						
Material/Energy Balance						
Design						
Operating						
Flow/Amount Measurements						
Stream						
Analyses/Assays						
Streams						
Process Description						
Operating Manuals						
Equipment List						
Equipment Specifications						
Piping and Instrument Diagrams						
Plot and Elevation						
Work Flow Diagrams						
Hazardous Waste Manifest						
Emission Inventories						
Annual/Biennial Reports						
Environmental Audit Reports						
Permit/Permit Applications						
Batch Sheet(s)						
Materials Application Diagram						
Product Composition Sheets						
Material Safety Data Sheets						
Inventory Records						
Operator Logs						
Production Schedules						

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WORKSHEET

4

INPUT MATERIALS SUMMARY

Attribute	Description		
	Stream No.	Stream No.	Stream No.
Name/ID			
Source/Supplier			
Component/Attribute of Concern			
Annual Consumption Rate			
Overall			
Component(s) of Concern			
Purchase Price, \$ per			
Overall Annual Cost			
Delivery Mode ¹			
Shipping Container Size & Type ²			
Storage Mode ⁵			
Transfer Mode ⁴			
Empty Container Disposal Management ⁵			
Shelf Life			
Supplier Would			
- accept expired material? (Y/N)			
- accept shipping containers? (Y/N)			
- revise expiration date? (Y/N)			
Acceptable Substitute(s), if any			
Alternate Supplier(s)			

- Notes:
1. e.g., pipeline, tank car, 100 bbl tank truck, truck, etc.
 2. e.g., 55 gal drum 100 lb paper bag, tank, etc.
 3. e.g., outdoor, warehouse, underground, aboveground, etc.
 4. e.g., pump, forklift, pneumatic transport, conveyor, etc.
 5. e.g., crush and landfill, clean and recycle, return to supplier, etc.

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WORKSHEET
5
PRODUCTS SUMMARY

Attribute	Description		
	Stream No.	Stream No.	Stream No.
Name/ID			
Component/Attribute of Concern			
Annual Production Rate			
Overall			
Component(s) of Concern			
Annual Revenues, \$			
Shipping Mode			
Shipping Container Size & Type			
Onsite Storage Mode			
Containers Returnable (Y/N)			
Shelf Life			
Rework Possible (Y/N)			
Customer Would			
- relax specification (Y/N)			
- accept larger containers (Y/N)			

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WORKSHEET

6

WASTE STREAM SUMMARY

Attribute	Description		
	Stream No. _____	Stream No. _____	Stream No. _____
Waste ID/Name:			
Source/Origin			
Component or Property of Concern			
Annual Generation Rate (units _____)			
Overall			
Component(s) of Concern			
Cost of Disposal			
Unit Cost (\$ per: _____)			
Overall (per year)			
Methods of Management ¹			

Priority Rating Criteria ²	Relative Wt. (W)	Rating (R)	R x W	Rating (R)	R x W	Rating (R)	R x W
Regulatory Compliance							
Treatment/Disposal Cost							
Potential Liability							
Waste Quantity Generated							
Waste Hazard							
Safety Hazard							
Minimization Potential							
Potential to Remove Bottleneck							
Potential By-Product Recovery	(R x W)		(R x W)		(R x W)		
Sum of Priority Rating Scores							
Priority Rank							

Notes: 1. For example, sanitary landfill, hazardous waste landfill, on-site recycle, incineration, combustion with heat recovery, distillation, dewatering, etc.
 2. Rate each stream in each category on a scale from 0 (none) to 10 (high).

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WORKSHEET

8

OPTION DESCRIPTION

Option Name: _____

Briefly describe the option: _____

Waste Stream(s) Affected: _____

Input Material(s) Affected: _____

Product(s) Affected: _____

Indicate Type: ☐ Source Reduction

☐ Equipment-Related Change

☐ Personnel/Procedure-Related Change

☐ Materials-Related Change

☐ Recycling/Reuse

☐ Onsite ☐ Material reused for original purpose

☐ Offsite ☐ Material used for a lower-quality purpose

☐ Material sold

Originally proposed by: _____ Date: _____

Reviewed by: _____ Date: _____

Approved for study? _____ Yes _____ No _____ By: _____

Reason for Acceptance or Rejection _____

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WORKSHEET

9

PROFITABILITY

Capital Cost _____

Purchased Equipment _____

Materials _____

Installation _____

Utility Connections _____

Engineering _____

Start-up and Training _____

Other Capital Costs _____

Total Capital Cost _____

Incremental Annual Operating Costs

Change in Disposal Costs _____

Change in Raw Material Costs _____

Change in Other Costs _____

Annual Net Operating Costs Savings _____

Payback Period (in years) = $\frac{\text{Total Capital Costs}}{\text{Annual Net Operating Cost Savings}}$ = _____

APPENDIX 3

The Option Rating Weighted Sum Method

This appendix offers an approach to ranking and selecting the best of your pollution prevention opportunities based on a numerical weighting system similar to that used for purchasing or reviewing tenders for capital acquisitions reviews.

It is a simple mathematical model that once fine-tuned to your needs and priorities, will efficiently and fairly rank your best value-added opportunities.

APPENDIX 3

OPTION RATING WEIGHTED SUM METHOD

The Weighted Sum Method is a quantitative method for screening and ranking pollution prevention options. This method provides a means of quantifying the important criteria that affect waste management in a particular facility. This method involves three steps.

1. Determine what the important criteria are in terms of the program goals and constraints and the overall corporate goals and constraints. Example criteria are:
 - Reduction in waste quantity
 - Reduction in waste hazard (e.g., toxicity, flammability, reactivity)
 - Reduction in waste treatment/disposal costs
 - Reduction in raw material costs
 - Reduction in liability and insurance costs
 - Previous successful use within the company
 - Previous successful use in industry
 - Not detrimental to product quality
 - Low capital cost
 - Low operating and maintenance costs
 - Short implementation period with minimal disruption of plant operations

The weights (on a scale of 0 to 10, for example) are determined for each of the criteria in relation to their importance. For example, if reduction in waste treatment and disposal costs are very important, while previous successful use within the company is of minor importance, then the reduction in waste costs is given a weight of 10 and the previous use within the company is given a weight of either 1 or 2. Criteria that are not important are not included or are given a weight of 0.

2. Each option is then rated on each criterion.
Again a scale to 0 to 10 can be used (0 for low and 10 for high).

3. Finally, the rating of each option for a particular criterion is multiplied by the weight of the criterion. An option's overall rating is the sum of the products of rating times the weight of the criterion.

The options with the best overall ratings are then selected for the technical and economic feasibility analyses. Table E-1 presents an example using the Weighted Sum Method for screening and ranking options.

Table E-1. Sample Calculation Using the Weighted Sum Method

ABC Corporation has determined that reduction in waste treatment costs is the most important criterion, with a weighted factor of 10. Other significant criteria include reduction in safety hazard (weight of 8), reduction in liability (weight of 7), and ease of implementation (weight of 5). Options X, Y, and Z are then each assigned effectiveness factors. For example, option X is expected to reduce waste by nearly 80%, and is given a rating of 8. It is given a rating of 6 for reducing and safety hazards, 4 for reducing liability, and because it is somewhat difficult to implement, 2 for ease of implementation. The table below shows how the options are rated overall, with effectiveness factors estimated for Y and Z.

<u>Rating Criteria</u>	<u>Ratings for each option</u>			
	<u>Weight</u>	<u>X</u>	<u>Y</u>	<u>Z</u>
Reduce treatment costs	10	8	6	3
Reduce safety hazards	8	6	3	8
Reduce liability	7	4	4	5
Ease of implementation	5	2	2	8
Sum of weight times ratings		166	122	169

From this screening, option Z rates the highest with a score of 169. Option X's score is 166 and option Y's score is 122. In this case, both option Z and option X should be selected for further evaluation because their scores are high and close to each other.

ECONOMIC EVALUATION EXAMPLE

The following example presents a profitability analysis for a relatively large hypothetical pollution prevention project. This project represents the installation of a package unit that improves plant production while reducing raw material consumption and disposal costs. The analysis was done on a personal computer using a standard spreadsheet program. The salient data used in this evaluation are summarized below.

Capital Costs

- The delivered price of the equipment is quoted by the vendor at \$170,000. This includes taxes and insurance.
- Materials costs (piping, wiring, and concrete) are estimated at \$35,000.
- Installation labour is estimated at \$25,000.
- Internal engineering staff costs are estimated at \$7,000. Outside consultant and contractor costs are estimated at \$15,000.
- Working capital (including chemical inventories, materials, and supplies) is estimated at \$5,000.
- Startup costs are estimated by the vendor at \$3,000.
- A contingency fund of \$20,000 for unforeseen costs and/or overruns is included.
- Planning, design, and installation are expected to take 1 year.

Financing

- The project will be financed 60% by retained earnings and 40% by a bank loan.
- The bank loan will be repaid over 5 years of equal instalments of principal plus interest at an annual percentage rate of 13%. Interest accrued during installation will be added into the total

capital costs

- All capital costs, except working capital and interest accrued during construction, will be depreciated over 7 years using the double-declining balance method, switching to the straight-line method when the charges by this method become greater.
- The marginal income tax rate is 34%.
- Escalation of all costs is assumed to be 5% per year for the life of the project.
- The firm's cost of capital is 15%.

Operating Costs and Revenues

- The pollution prevention project is estimated to decrease raw material consumption by 300 units per year at a cost of \$50 per unit. The project will not result in increased production. However, it will produce a marketable by-product to be recovered at a rate of 200 units per year and a price of \$25 per unit.
- The project will reduce the quantity of hazardous waste disposed by 200 tons per year. The following items make the total unit disposal costs:

	<u>Costs per ton of waste</u>
Offsite disposal fees	\$500
State generator taxes	10
Transportation costs	25
Other costs	25
	<hr/>
TOTAL DISPOSAL COSTS	\$560

- Incremental operating labour costs are estimated on the basis that the project is expected to require 1 hour of operator's time per 8-hour shift. There are 3 shifts per day and the plant operates 350 days per year. The wage rate for operators is \$12.50 per hour.
- Operating supplies expenses are estimated at 30% of operating labour costs.
- Maintenance labour costs are estimated at 2% of the sum of the capital cost for equipment, materials, and installation. Maintenance supplies costs are estimated at 1% of these costs.
- Incremental supervision costs are estimated at 30% of the combined costs of operating and maintenance labour.
- The following overhead costs are estimated as a percentage of the sum of operating and maintenance labour and supervision costs.

Labour burden and benefit	28%
Plant overhead	25%
Headquarter overhead	20%

- Escalation of all costs is assumed to be 5% per year for the life of the project.
- The project life is expected to be 8 years.
- The salvage value of the project is expected to be zero after 8 years.

Results

The four-page printout in Figures F-1 through F-4 presents the pollution prevention project profitability spreadsheet program. Figure F-1 represents the input section of the program. Each of the numbers in the first three columns represents an input variable in the program. The right hand side of Figure F-1 is a summary of the capital requirement. This includes a calculation of the interest accrued during construction and the financing structure of the project.

Figure F-2 is a table of the revenues and operating costs items for each of the 8 years of the project's operating life. These costs are escalated by 5% each year for the life of the project.

Figure F-3 presents the annual cash flows for the project. The calculation of depreciation charges and the payment of interest and repayment of loan principal are also shown here. the calculation of the internal rate of return (IRR) and the net present value (NPV) are based on the annual cash flows. Because the project is leveraged (financed partly by a bank loan), the equity portion of the investment is used as the initial cash flows. The NPV and the IRR are calculated on the basis. The IRR calculated this way is referred to as the "return on equity".

The program is structured to present the NPV and IRR after each year of the project's operating life. In the example, after 6 years, the IRR is 19.92% and the NPV is \$27,227.

Figure F-4 is a cash flow table based entirely on equity financing. Therefore, there are no interest payments or debt principal repayments. The NPV and the IRR in this case are based on the entire capital investment in the project. The IRR calculated this way is referred to as the "return on investment".

The results of the profitability analysis for this project are summarized below:

Method of Financing	IRR	NPV
60% equity/40% debt	26.47%	\$84,844
100% equity	23.09%	\$81,625

The IRR values are greater than the 15% cost of capital, and the NPVs are positive. Therefore, the project is attractive and should be implemented.

[illegible]

Figure F-3. Cash Flows for Return on Equity

RETURN ON INVESTMENT									
Construction Year	1								
Operating Year		1	2	3	4	5	6	7	8
Book Value	\$290,000	\$207,143	\$147,959	\$105,685	\$64,257	\$22,828	\$0	\$0	\$0
Depreciation (by straight-line)		\$41,429	\$41,429	\$41,429	\$41,429	\$41,429	\$41,429	\$0	\$0
Depreciation (by double DB)		\$82,857	\$59,184	\$42,274	\$30,196	\$18,359	\$6,522	\$0	\$0
Depreciation		\$82,857	\$59,184	\$42,274	\$41,429	\$41,429	\$22,828	\$0	\$0
CASH FLOWS									
Construction Year	1								
Operating Year		1	2	3	4	5	6	7	8
Revenues		\$8,400	\$8,820	\$9,261	\$9,724	\$10,210	\$10,721	\$11,257	\$11,820
+ Operating Savings		\$82,134	\$86,240	\$90,552	\$95,080	\$99,834	\$104,826	\$110,067	\$115,570
Net Revenues		\$90,534	\$95,060	\$99,813	\$104,804	\$110,044	\$115,546	\$121,324	\$127,390
- Depreciation		\$82,857	\$59,184	\$42,274	\$41,429	\$41,429	\$22,828	\$0	\$0
Taxable Income		\$7,677	\$35,877	\$57,539	\$63,375	\$68,616	\$92,718	\$121,324	\$127,390
- Income Tax		\$2,610	\$12,198	\$19,563	\$21,548	\$23,329	\$31,524	\$41,250	\$43,313
Profit after Tax		\$5,066	\$23,679	\$37,976	\$41,828	\$45,286	\$61,194	\$80,074	\$84,077
+ Depreciation		\$82,857	\$59,184	\$42,274	\$41,429	\$41,429	\$22,828	\$0	\$0
After-Tax Cash Flow		\$87,924	\$82,862	\$80,250	\$83,256	\$86,715	\$84,022	\$80,074	\$84,077
Cash Flow for ROI	(\$295,000)	\$87,924	\$82,862	\$80,250	\$83,256	\$86,715	\$84,022	\$80,074	\$84,077
Net Present Value	(\$295,000)	(\$218,545)	(\$155,889)	(\$103,123)	(\$55,521)	(\$12,408)	\$23,917	\$54,019	\$81,504
Return on Investment		-70.20%	-30.04%	-7.77%	5.25%	13.20%	17.98%	20.96%	23.08%
23.08%									

Figure F-4. Cash Flows Based on Equity Financing

APPENDIX 4

Pollution Prevention Checklists General & Industry Specific

This appendix tabulates information that may be helpful to you if you decide to customize the worksheets in Appendix 2 for your own company's needs. Some ideas for achieving pollution prevention through good operating practices are shown in Table 1. Approaches to pollution prevention in material receiving, raw material and product storage, laboratories, and maintenance areas are shown in Table 2. Information in these two tables can apply to a wide range of industries. Industry-specific checklists for five example industries are presented in Tables 3 through 7. See Appendix 6 for a list of publications that provide industry-specific information related to pollution prevention. The tables contained within this appendix are as follows:

Table 1. Pollution Prevention Through Good Operating Practices

Table 2. Checklist for All Industries

Table 3. Checklist for the Printing Industry

Table 4. Checklist for the Fabricated Metal Industry

Table 5. Checklist for the Metal Casting Industry

Table 6. Checklist for the Printed Circuit Board Industry

Table 7. Checklist for the Coating Industry

Table 1. Pollution Prevention Through Good Operating Practices

Good Operating Practice	PROGRAM INGREDIENTS
Waste Segregation	<ul style="list-style-type: none"> • Prevent mixing of hazardous wastes with nonhazardous wastes • Store materials in compatible groups • Segregate different solvents • Isolate liquid wastes from solid wastes
Preventive Maintenance Programs	<ul style="list-style-type: none"> • Maintain equipment history cards on equipment location, characteristics, and maintenance • Maintain a master preventive maintenance (PM) schedule • Keep vendor maintenance manuals handy • Maintain a manual or computerized repair history file
Training/Awareness Building Programs	<p>Provide Training For;</p> <ul style="list-style-type: none"> • Operation of the equipment to minimize energy use and material waste • Proper materials handling to reduce waste and spills • Emphasize importance of pollution prevention by explaining the economic and environmental ramifications of hazardous waste generation and disposal • Detecting and minimizing material loss to air, land, or water • Emergency procedures to minimize lost materials during accidents
Effective Supervision	<ul style="list-style-type: none"> • Closer supervision may improve production efficiency and reduce inadvertent waste generation • Centralize waste management. Appoint a safety/waste management officer for each department. Educate staff on the benefits of pollution prevention. Establish pollution prevention goals. Perform pollution prevention assessments.
Employee Participation	<ul style="list-style-type: none"> • "Quality circles" (free forums between employees and supervisors) can identify ways to reduce waste • Solicit and reward employee suggestions for waste reduction ideas
Production Scheduling/Plan	<ul style="list-style-type: none"> • Maximize batch size to reduce clean out waste • Dedicate equipment to a single product • Alter batch sequencing to minimize cleaning frequency (light-to-dark batch sequence, for example)
Cost accounting/ Allocation	<ul style="list-style-type: none"> • Charge direct and indirect costs of all air, land, and water discharges to specific processes or products • Allocate waste treatment and disposal costs to the operations that generate the waste • Allocate utility costs to specific processes or products

Table 2. Checklist for All Industries

WASTE ORIGIN/TYPE	POLLUTION PREVENTION AND RECYCLING METHODS
<p>Material Receiving</p> <p>packaging materials, off-spec materials, damaged container, inadvertent spills, transfer hose emptying</p>	<ul style="list-style-type: none"> • Use "Just-in-Time" ordering system. • Establish a centralized purchasing program. • Select quantity and package type to minimize packing waste. • Order reagent chemicals in exact amounts. • Encourage chemical suppliers to become responsible partners (e.g., accept outdated supplies). • Establish an inventory control program to trace chemical from cradle to grave. • Rotate chemical stock. • Develop a running inventory of unused chemicals for other departments' use. • Inspect material before accepting a shipment. • Review material procurement specifications. • Validate shelf-life expiration dates. • Test effectiveness of outdated material. • Eliminate shelf-life requirements for stable compounds. • Conduct frequent inventory checks. • Use computer-assisted plant inventory system. • Conduct periodic materials tracking. • Properly label all containers. • Set up staffed control points to dispense chemicals and collect wastes. • Buy pure feeds. • Find less critical uses for off-spec material (that would otherwise be disposed). • Change to reusable shipping containers. • Switch to less hazardous raw material. • Use rinsable/recyclable drums.
<p>Laboratories/Reagents</p> <p>off-spec chemicals, samples, empty sample and chemical containers</p>	<ul style="list-style-type: none"> • Use micro or semi-micro analytical techniques. • Increase use of instrumentation. • Reduce or eliminate the use of highly toxic chemicals in laboratory experiments. • Reuse/recycle spent solvents. • Recover metal from catalyst. • Treat or destroy hazardous waste products as the last step in experiments. • Keep individual hazardous waste streams segregated, segregate hazardous waste from nonhazardous waste, segregate recyclable waste from non-recyclable waste. • Assure that the identity of all chemicals and wastes is clearly marked on all containers. • Investigate mercury recovery and recycling.

WASTE ORIGIN/TYPE	POLLUTION PREVENTION AND RECYCLING METHODS
<p>Raw Material and Product Storage</p> <p>tank bottoms; off-spec and excess materials; spill residues; leaking pumps, valves, tanks, and pipes; damaged containers; empty containers</p>	<ul style="list-style-type: none"> • Establish Spill Prevention, Control, and Countermeasures (SPCC) plans. • Use properly designed tanks and vessels only for their intended purposes. • Install overflow alarms for all tanks and vessels. • Maintain physical integrity of all tanks and vessels. • Set up written procedures for all loading/unloading and transfer operations. • Install secondary containment areas. • Instruct operators to not bypass interlocks, alarms, or significantly alter setpoints without authorization. • Isolate equipment or process lines that leak or are not in service. • Use sealless pumps. • Use bellows-seal valves. • Document all spillage. • Perform overall materials balances and estimate the quantity and dollar value of all losses. • Use floating-roof tanks for VOC control. • Use conservation vents on fixed roof tanks. • Use vapor recovery systems. • Store containers in such a way as to allow for visual inspection for corrosion and leaks. • Stack containers in a way to minimize the chance of tipping, puncturing, or breaking. • Prevent concrete "sweating" by raising the drum off storage pads. • Maintain Material Safety Data Sheets to ensure correct handling of spills. • Provide adequate lighting in the storage area. • Maintain a clean, even surface in transportation areas. • Keep aisles clear of obstruction. • Maintain distance between incompatible chemicals. • Maintain distance between different types of chemicals to prevent cross-contamination. • Avoid stacking containers against process equipment. • Follow manufacturers' suggestions on the storage and handling of all raw materials. • Use proper insulation of electric circuitry and inspect regularly for corrosion and potential sparking. • Use large containers for bulk storage whenever possible. • Use containers with height-to-diameter ratio equal to one to minimize wetted area. • Empty drums and containers thoroughly before cleaning or disposal. • Reuse scrap paper for note pads; recycle paper.

WASTE ORIGIN/TYPE	POLLUTION PREVENTION AND RECYCLING METHODS
<p>Operation and Process Changes</p> <p>solvents, cleaning agents, degreasing sludges, sandblasting waste, caustic, scrap metal, oils, greases from equipment cleaning</p>	<ul style="list-style-type: none"> • Maximize dedication of process equipment. • Use squeegees to recover residual fluid on product prior to rinsing. • Use closed storage and transfer systems. • Provide sufficient drain time for liquids. • Line equipment to reduce fluid holdup. • Use cleaning system that avoid or minimize solvents and clean only when needed. • Use countercurrent rinsing. • Use clean-in-place systems. • Clean equipment immediately after use. • Reuse cleanup solvent. • Reprocess cleanup solvent into useful products. • Segregate wastes by solvent type. • Standardize solvent usage. • Reclaim solvent by distillation. • Schedule production to lower cleaning frequency. • Use mechanical wipers on mixing tanks.
<p>Operation and Process Changes</p> <p>sludge and spent acid from heat exchanger cleaning</p>	<ul style="list-style-type: none"> • Use bypass control or pumped recycle to maintain turbulence during turndown. • Use smooth heat exchange surfaces. • Use on-stream cleaning techniques. • Use high pressure water cleaning to replace chemical cleaning where possible. • Use lower pressure steam.

Table 3. Checklist for the Printing Industry

WASTE ORIGIN/TYPE	POLLUTION PREVENTION AND RECYCLING METHODS
Image Processing empty containers, used film packages, outdated material	<ul style="list-style-type: none"> • Recycle empty containers. • Recycle spoiled photographic film.
Image Processing photographic chemicals silver	<ul style="list-style-type: none"> • Use silver-free films, such as vesicular, diazo, or electrostatic types. • Use water-developed litho plates. • Extend bath life. • Use squeegees to reduce carryover. • Employ countercurrent washing. • Recover silver and recycle chemicals.
Plate Making damaged plates, developed film, outdated materials	<ul style="list-style-type: none"> • Use electronic imaging, laser plate making.
Plate Making acids, alkali, solvents, plate coatings (may contain dyes, photopolymers, binders, resins, pigment, organic acids), developers (may contain isopropanol, gum arabic, lacquers, caustics), and rinse water	<ul style="list-style-type: none"> • Electronic imaging/laser print making. • Recover silver and recycle chemicals. • Use floating lids on bleach and developer tanks. • Use countercurrent washing sequence. • Use squeegees to reduce carryover. • Substitute iron-EDTA for ferrocyanide. • Use washless processing systems. • Use better operating practices. • Remove heavy metals from wastewater.
Finishing damaged products, scrap	<ul style="list-style-type: none"> • Reduce paper use and recycle waste paper.
Printing lubricating oils, waste ink, cleanup solvent (halogenated and nonhalogenated), rags	<ul style="list-style-type: none"> • Prepare only the quantity of ink needed for a press run. • Recycle waste ink and solvent • Schedule runs to reduce color change over. • Use automatic cleaning equipment. • Use automatic ink leveller. • Use alternative solvents. • Use water-based ink. • Use UV-curable ink. • Install web break detectors. • Use automatic web splicers. • Store ink properly. • Standardize ink sequence. • Recycle waste ink.

WASTE ORIGIN/TYPE	POLLUTION PREVENTION AND RECYCLING METHODS
Printing test production, bad printings, empty ink containers, used blankets.	<ul style="list-style-type: none"> • Install web break detectors. • Monitor press performance. • Use better operating practices. • Use alternative fountain solutions. • Use alternative cleaning solvents. • Use automatic blanket cleaners. • Improve cleaning efficiency. • Collect and reuse solvent. • Recycle lube oils.
Finishing paper waste from damaged product	<ul style="list-style-type: none"> • Reduce paper use. • Recycle waste paper.

Table 4. Checklist for the Fabricated Metal Industry

WASTE ORIGIN/TYPE	POLLUTION PREVENTION AND RECYCLING METHODS
Machining Wastes/Metalworking Fluid	<ul style="list-style-type: none"> • Use of high-quality metalworking fluid. • Use demineralized water makeup. • Perform regularly scheduled sump and machine cleaning. • Perform regularly scheduled gasket, wiper, and seal maintenance. • Filter, pasteurize, and treat metalworking fluid for reuse. • Assigning fluid control responsibility to one person. • Standardize oil types used on machining equipment. • Improve equipment scheduling/establish dedicated lines. • Reuse or recycle cutting, cooling, and lubricating oils. • Substitute insoluble borates for soluble borate lubricants.
Machining Wastes metal wastes, dust, and sludge	<ul style="list-style-type: none"> • Segregate and reuse scrap metal.
Parts Cleaning/Solvents	<ul style="list-style-type: none"> • Install lids/silhouettes on tanks. • Increase freeboard space on tanks. • Install freeboard chillers on tanks. • Remove sludge from solvent tanks frequently. • Extend solvent life by precleaning parts by wiping, using air blowers, or predipping in cold mineral spirits dip. • Reclaim/recover solvent on- or off-site. • Substitute less hazardous solvent degreasers (e.g., petroleum solvents instead of chlorinated solvents) or alkali washes where possible. • Distribute parts on rack to allow good cleaning and minimize solvent holdup. • Slow speed of parts removal from vapor zone. • Rotate parts to allow condensed solvent drop-off.
Parts Cleaning/Rinsewater	<ul style="list-style-type: none"> • Improve rack and barrel system design. • Use spray, fog, or chemical rinses. • Use deionized water makeup to increase solution life.
Parts Cleaning/Abrasives	<ul style="list-style-type: none"> • Use of greaseless or water-based binders. • Use an automatic liquid spray system for application of abrasive onto wheel. • Ensure sufficient water use during cleaning by using water level control. • Use synthetic abrasives.

WASTE ORIGIN/TYPE	POLLUTION PREVENTION AND RECYCLING METHODS
Surface Treatment and Plating/ Process Solutions	<ul style="list-style-type: none"> • Use material or process substitution e.g., trivalent chromium. • Use low solvent paint for coating. • Use mechanical cladding and coating. • Use cleaning baths as pH adjusters. • Recover metals from process solutions.
Surface Treatment and Plating/ Rinsewater	<ul style="list-style-type: none"> • Reduction in drag-out of process chemicals: <ul style="list-style-type: none"> - Reduce speed of withdrawal - Lower plating bath concentrations - Reuse rinsewater - Use surfactants to improve drainage - Increase solution temperature to reduce viscosity - Position workpiece to minimize solution holdup • System design considerations: <ul style="list-style-type: none"> - Rinsetank design - Multiple rinsing tanks - Conductivity measurement to control rinse water flow - Fog nozzles and sprays - Automatic flow controls - Rinse bath agitation - Counter current rinse.

Table 5. Checklist for the Metal Casting Industry

WASTE ORIGIN/TYPE	POLLUTION PREVENTION AND RECYCLING METHODS
<p>Baghouse Dust and Scrubber Waste</p> <p>dust contaminated with lead, zinc, and cadmium</p>	<ul style="list-style-type: none"> • Identify the source of contaminants, e.g., coatings on scrap, and work with suppliers to find raw materials that reduce the contaminant input. • Install induction furnaces to reduce dust production. • Recycle dust to original process or to another process. • Recover contaminants with pyrometallurgical treatment, rotary kiln, hydrogen reduction, or other processes. • Recycle to cement manufacturer.
<p>Production of Ductile Iron</p> <p>hazardous slag</p>	<ul style="list-style-type: none"> • Reduce the amount of sulfur in the feedstock. • Use calcium oxide or calcium fluoride to replace calcium carbide as the desulfurization agent. • Improve process control. • Recycle calcium carbide slag.
<p>Casting</p> <p>spent casting sand</p>	<ul style="list-style-type: none"> • Material substitution, e.g., olivine sand is more difficult to detoxify than silica sand. • Separate sand and shot blast dust. • Improve metal recovery from sand. • Recover sand and mix old and new sand for mold making. • Recover sand by washing, air scrubbing, or thermal treatment. • Reuse sand for construction if possible.

Table 6. Checklist for the Printed Circuit Board Industry

WASTE ORIGIN/TYPE	POLLUTION PREVENTION AND RECYCLING METHODS
PC Board Manufacture/ General	<ul style="list-style-type: none"> • Product substitution: <ul style="list-style-type: none"> - Surface mount technology - Injection molded substrate and additive plating
Cleaning and Surface Preparation/Solvents	<ul style="list-style-type: none"> • Materials substitution: <ul style="list-style-type: none"> - Use abrasives - Use nonchelated cleaners • Increase efficiency of process: <ul style="list-style-type: none"> - Extend bath life, improve rinse efficiency, countercurrent cleaning • Recycle/reuse: <ul style="list-style-type: none"> - Recycle/reuse cleaners and rinses
Pattern Printing and Masking acid fumes/organic vapors; vinyl polymers spent resist removal solution; spent acid solution: waste rinse water	<ul style="list-style-type: none"> • Reduce hazardous nature of process: <ul style="list-style-type: none"> - Aqueous processable resist - Screen printing versus photolithography - Dry photoresist removal • Recycle/reuse: <ul style="list-style-type: none"> - Recycle/reuse photoresist stripper
Etching etching solutions and rinse wastes	<ul style="list-style-type: none"> • Eliminate process: <ul style="list-style-type: none"> - Differential plating - Use dry plasma etching. • Materials substitution: <ul style="list-style-type: none"> - Nonchelated etchants - Nonchrome etchants. • Increased efficiency: <ul style="list-style-type: none"> - Use thinner copper cladding - Pattern vs. panel plating - Additive vs. subtractive method. • Reuse/recycle: <ul style="list-style-type: none"> - Reuse/recycle etchants.

WASTE ORIGIN/TYPE	POLLUTION PREVENTION AND RECYCLING METHODS
<p>Electroplating and Electroless Plating</p> <p>plating solutions and rinse wastes</p>	<ul style="list-style-type: none"> • Eliminate process: <ul style="list-style-type: none"> - Mechanical board production • Materials substitution: <ul style="list-style-type: none"> - Noncyanide baths - Noncyanide stress relievers • Extend bath life; reduce drag-in: <ul style="list-style-type: none"> - Proper rack design/maintenance, better precleaning/ rinsing, use of demineralized water as makeup, proper storage methods • Extend bath life; reduce drag-out: <ul style="list-style-type: none"> - Minimize bath chemical concentration, increase bath temperature, use wetting agents, proper positioning on rack, slow withdrawal and sample drainage, computerized/automated systems, recover drag-out, use airstreams or fog to rinse plating solution into the tank, collect drips with drain boards. • Extend bath life; maintain bath solution quality: <ul style="list-style-type: none"> - Monitor solution activity - Control temperature - Mechanical agitation - Continuous filtration/carbon treatment - Impurity removal • Improve rinse efficiency: <ul style="list-style-type: none"> - Closed-circuit rinses - Spray rinses - Fog nozzles - Increased agitation - Countercurrent rinsing - Proper equipment design/operation - Deionized water use. • Turn off rinsewater when not in use. • Recovery/reuse: <ul style="list-style-type: none"> - Segregate streams - Recover metal values.

Table 7. Checklist for the Coating Industry

WASTE ORIGIN/TYPE	POLLUTION PREVENTION AND RECYCLING METHODS
<p>Coating Overspray</p> <p>coating material that fails to reach the object being coated</p>	<ul style="list-style-type: none"> • Maintain 50% overlap between spray pattern. • Maintain 6- to 8-inch distance between spray gun and the workpiece. • Maintain a gun speed of about 250 feet/minute. • Hold gun perpendicular to the surface. • Trigger gun at the beginning and end of each pass. • Properly train operators. • Use robots for spraying. • Avoid excessive air pressure for coating atomization. • Recycle overspray. • Use electrostatic spray systems. • Use turbine disk or bell or air-assisted airless spray guns in place of air-spray guns. • Install on-site paint mixers to control material usage. • Inspect parts before coating.
<p>Stripping Wastes</p> <p>coating removal from parts before applying a new coat</p>	<ul style="list-style-type: none"> • Avoid adding excess stripper. • Use spent stripper as rough prestrip on next item. • Use abrasive media paint stripping. • Use plastic media bead-blasting paint stripping. • Use cryogenic paint stripping. • Use thermal paint stripping. • Use wheat starch media blasting paint stripping. • Use laser or flashlamp paint stripping.
<p>Solvent Emissions</p> <p>evaporative losses from process equipment and coated parts</p>	<ul style="list-style-type: none"> • Keep solvent soak tanks away from heat sources. • Use high-solids coating formulations. • Use powder coatings. • Use water-based coating formulations. • Use UV cured coating formulations.
<p>Equipment Cleanup Wastes</p> <p>process equipment cleaning with solvents</p>	<ul style="list-style-type: none"> • Use light-to-dark batch sequencing. • Produce large batches of similarly coated objects-instead of small batches of differently coated items. • Isolate solvent-based paint spray booths from water-based paint spray booths. • Reuse cleaning solution/solvent. • Standardize solvent usage. • Clean coating equipment after each use.
<p>Source Reduction</p>	<ul style="list-style-type: none"> • Reexamine the need for coating, as well as available alternatives. • Use longer lasting plastic coatings instead of paint.

APPENDIX 5

Technical/ Financial Assistance Programs

APPENDIX 5

TECHNICAL/FINANCIAL ASSISTANCE PROGRAMS

There are a number of organizations that can assist you in developing and maintaining a pollution prevention program. This appendix lists branches and corporations of the Ontario Government as well as a selection of offices of the Canadian Federal Government; U.S. EPA, state agencies, universities and other organizations that may be able to provide assistance.

PROVINCIAL ORGANIZATIONS - ONTARIO

Ministry of the Environment and Energy

Pollution Prevention Office
40 St. Clair Avenue West, 11th Floor
Toronto, Ontario
M4V 1M2
Phone (416) 314-7910
FAX (416) 314-7930

The following lists some of the financial and assistance programs open to industries, municipalities and other organizations:

- Industrial Waste Diversion Program (Program Development Branch)
- Environmental Technologies Program (Fiscal Planning and Information Management Branch)
- Environmental Research Program (Research & Technology Branch)
- Pesticides Research Grants
- Household Special Waste Collection Program
- Assistance for Municipal 3Rs
- Financial Assistance for Waste Management Facilities
- Environmental Education and Awareness Program

Details on these and other programs are available through the publication entitled **SUPPORT PROGRAMS FOR ENVIRONMENTAL PROJECTS IN ONTARIO** (October 1992):

Ministry of the Environment and Energy
Fiscal Planning and Information Management Branch
Research and Technology Section
135 St. Clair Avenue West, 11th Floor
Toronto, Ontario
M4V 1P5
Phone (416) 323-4581
Fax (416) 323-4322

Energy programs are available to industry, commercial building operators, municipalities, educators, community groups and First Nations as well as a variety of businesses and organizations for the development or implementation of energy efficient technologies and practices. Ministry staff work directly with industries and businesses to help companies assess energy use and improve energy performance.

Ministry of Environment and Energy
56 Wellesley Street West
Toronto, Ontario
M7A 2B7

General Inquiries: (416) 327-1234

Toll Free: 1 800 ENERGY1

◆ **Green Industry Office, 10th Floor**

(416) 327-2984

The Green Industry Office is developing a Green Industry Strategy to increase Ontario industrial capabilities in the green products and services sector and to identify and encourage the growth of market opportunities for these products and technologies. The ultimate goal of the strategy is a globally competitive green industry in Ontario.

◆ **Energy Programs & Technology Division, 12th Floor**

The Energy Programs & Technology Division encourages the development of energy-efficient equipment and practices in all sectors of the Ontario economy including community groups, government, municipalities, public institutions such as hospitals and schools, industry and the general public. The division has the following operational sections.

◆ **Industry Programs Section, 14th Floor**

(416) 327-1441 Industrial Energy Services Program
 Industrial Retrofits

(416) 327-1442 Industrial Process Equipment Demonstration Program
 Market Entry of Energy-Efficient Technologies
 Renewable Energy

The Industry Programs Section assists Ontario industries in improving their energy efficiency performance through programs

focusing on energy equipment and process improvements. It provides engineering advice and information, and assists in identifying, assessing and marketing energy technologies. Grants are available for feasibility studies, project engineering design and demonstrations and the purchase and installation of energy-efficient equipment. Services include energy audits, technology fact sheets and seminars.

◆ **Building Energy Use Section, 10th Floor**

(416) 327-2981 General Information
(416) 327-1266 Utilities Management Program
(416) 327-1267 Government Energy Management Program
(416) 327-2985 Residential & Commercial Programs

The Building Energy Use Section promotes action by private and public sector clients to reduce energy use and optimize fuel and technology choices in buildings. The section provides accurate information, funds demonstration of technology, coordinates programs based on innovative financing for public sector buildings and recommends prudent and effective regulations of energy use in buildings.

♦Energy Efficiency Section, 14th Floor

(416) 327-1475	Communities Outreach
(416) 327-1476	Transportation
(416) 327-1481	Standards Development
(416) 327-1484	Education & Training

The Energy Efficiency Section provides advisory services and financial support to: improve energy efficiency in participating communities including First Nations communities; develop energy performance standards for regulation under the Energy Efficiency Act; and develop and implement programs in energy education, energy management training and the transportation sector. The section supports product and market development initiatives related to alternative transportation fuels.

♦Energy Research and Development Section, 11th Floor

(416) 327-1255	EnerSearch Program
(416) 327-1253/1256	Technical Information

The Energy Research & Development Section assists Ontario industry and the research community in developing innovative energy technologies that will improve energy efficiency or increase supply options.

Ministry of Natural Resources

Water Conservation Strategy
Water Policy Section
Lands and Waters Policy Branch
Ministry of Natural Resources
Room 5620 Whitney Block
99 Wellesly St. W.
Toronto, Ontario
M7A 1W2
(416) 314-2351

Ontario Waste Management Corporation

Waste Reduction Group
2 Bloor Street West, 11th Floor
Toronto, Ontario
M4W 3E2
Phone (416) 923-2918

Ontario Waste Exchange

(A partnership project between ORTECH, MOEE & OWMC)

ORTECH International
2395 Speakman Drive
Mississauga, Ontario
Phone (416) 822-4111

The Development Corporations of Ontario

The Development Corporations of Ontario, are Crown agencies of the Ministry of Economic Development and Trade. The three regional corporations offer financial assistance in the form of loans and loan guarantees for manufacturing projects (e.g. business start-ups, plant expansions, upgrading or modernizing facilities, patent and license acquisition for new processes and products). Innovation Ontario Corporation invests in early stage, technology-based businesses. For more information contact:

The Development Corporations of Ontario
56 Wellesley Street West, 6th Floor
Toronto, Ontario
M7A 2E7
Phone (416) 326-1070
FAX (416) 326-1073

FEDERAL ORGANIZATIONS

Environment Canada

Development and Demonstration of Resource and Energy Conservation Technology (DIRECT) Program

- funding research for energy-efficient technology

DIRECT Secretariat
Environmental Protection Service
Environment Canada
Ottawa, Ontario
K1A 1C8
Phone (819) 953-1192

Industry Energy Research and Development Program (IERD)

- funding for energy conservation projects

IERD Secretariat
Department of Energy, Mines and Resources
580 Booth Street
Ottawa, Ontario
K1A 0E4
Phone (613) 996-2480

U.S. ENVIRONMENTAL PROTECTION AGENCY

Pollution Prevention Information Clearinghouse (PPIC)

The PPIC is dedicated to reducing industrial pollutants through technology transfer, education, and public awareness. It provides technical, policy, programmatic, legislative,, and financial information upon request.

The PPIC provides businesses and government agencies with information to assist them in a range of pollution prevention activities, such as:

- . Establishing pollution prevention programs.
- . Learning about new technical options arising from U.S. and foreign R & D.
- . Locating and ordering documents.
- . Identifying upcoming events.
- . Discovering grant and project funding opportunities.
- . Identifying pertinent legislation.
- . Saving money by reducing waste.

The PPIC disseminates this information through a number of services. These include:

- . a telephone hotline.
- . a repository of publications, reports, and industry-specific fact sheets.
- . an electronic information exchange network.
- . indexed bibliographies and abstracts of reports, publications, and case studies.
- . a calendar of conferences and seminars.
- . a directory of waste exchanges.
- . information packets and workshops.

The electronic network maintained by PPIC is designated as PIES. It provides access to information databases and can be used to place orders for documents. The subsystems of PIES include:

- . a message center.
- . a publication reference database.
- . a directory of experts.
- . case studies.
- . a calendar of events.
- . program studies.
- . legislation summaries.
- . topical mini-exchanges.

This interactive system can deliver information to the user through screen display, downloading, and FAX. It is available to off-site computers via modem 24 hours a day. For information on linking PIES, contact:

PIES Technical Assistance
Science Applications International Corp.
8400 Westpart Drive
McLean, VA 22102 (703) 821-4800

The PPIC operates a telephone hotline for questions and requests for information. The hotline provides users who cannot access PIES electronically with access to its information and services.

Other U.S. EPA offices that can provide pollution prevention information include:

U.S. EPA Solid Waste Office
Waste Management Division
401 M Street SW
Washington, D.C. 20460
(703)308-8402

U.S. EPA Office of Pollution Prevention and Toxics
401 M Street SW
Washington, D.C. 20460
(202)260-3810

STATE LEVEL

The following lists agencies at the state or territory level as well as universities and other organizations that can provide assistance in the areas of pollution prevention and treatment:

Alaska

Alaska Health Project
Waste Reduction Assistance Program
1818 West Northern Lights, Suite 103
Anchorage, AK 99517
(907)276-2864

Alaska Department of Environmental Conservation
Pollution Prevention Program
P.O. Box O
Juneau, AK 99811-1800
(907)465-2671

District of Columbia

U.S. Department of Energy
Conservation and Renewable Energy
Office of Industrial Technologies
Office of Waste Reduction
Waste Material Management Division
Bruce Cranford CE-222
Washington, D.C. 20585
(202)586-9496

Office of Recycling
D.C. Department of Public Works
2000 14th Street, NW, 8th Floor
Washington, D.C. 20009
(202)939-7116

Illinois

Hazardous Waste Research and Information Center
Illinois Department of Energy & Natural Resources
One E. Hazelwood Drive
Champaign, IL 61820
(217)333-8940

Industrial Waste Elimination Research Center
Pritzker Department of Environmental Engineering
Illinois Institute of Technology
3201 South Dearborn
Room 103 Alumni Memorial Hall
Chicago, IL 60616
(312)567-3535

Illinois Environmental Protection Agency
Office of Pollution Prevention
2200 Churchill Road
P.O. Box 19276
Springfield, IL 62794-9276
(217)782-8700

Michigan

Resource Recovery Section
Department of Natural Resources
P.O. Box 30241
Lansing, MI 48909
(517)373-0540

Office of Waste Reduction Services
Michigan Departments of Commerce and Natural Resources
P.O. Box 30004
Lansing, MI 48909
(517)335-1178

New Jersey

New Jersey Hazardous Waste Facilities Siting Commission
Room 614
28 West State Street
Trenton, NJ 08608
(609)292-1459
(609)292-1026

Hazardous Waste Advisement Program
New Jersey Department of Environmental Protection
& Energy
401 East State Street
Trenton, NJ 08625
(609)777-0518

New Jersey Institute of Technology
Hazardous Substance Management Research Center
Advanced Technology Center Building
323 Martin Luther King Jr. Boulevard
University Heights
Newark, NJ 07102
(201)596-5864

New Mexico

Economic Development Department
Bataan Memorial Building
State Capitol Complex
Santa Fe, NM 87503
(505)827-0380

Hazardous and Radiation Waste Bureau
Environmental Improvement Division
1190 St. Francis Drive
Santa Fe, NM 87503
(505)827-2926

New York

New York Environmental Facilities Corporation
50 Wolf Road
Albany, NY 12205
(518)457-4222

Environmental Compliance Services
Erie County Office Building
95 Franklin Street
Buffalo, NY 14202
(716)846-6716

Tennessee

Tennessee Valley Authority
Mail Code Old City Hall Building 2171b
Knoxville, TN 37901
(615)632-3160

Tennessee Valley Authority
Mail Code HV2S270C
Chattanooga, TN 37402
(615)751-3731

Tennessee Valley Authority
1195 Antioch Pike
Nashville, TN 37219
(615)360-1680

**Waste Reduction Assistance Program
Center for Industrial Services
University of Tennessee
226 Capitol Blvd. Building
Suite 606
Nashville, TN 37219
(615) 242-4816**

APPENDIX 6

Selected Bibliography

SELECTED BIBLIOGRAPHY

1. **Waste Reduction Action Plan; Part I Industrial/Commercial/Institutional/Solid Waste Assessment Guide**

Author: Association of Municipal Recycling Coordinators (AMRC), I/C/I Subcommittee
Publisher: Association of Municipal Recycling Coordinators (Canada)
Date: 1991

2. **Achieving Environmental Excellence: A Handbook for Canadian Business**

Author: Peat Marwick Stevenson and Kellogg
Publisher: Canadian Chamber of Commerce (Focus 200 Program)
Date: September 1990

3. **A Small Business Guide to Environmental Management**

Author: Peat Marwick Stevenson and Kellogg
Publisher: Canadian Chamber of Commerce (Focus 2000 Program)
Date: 1991

4. **The Environmental Manual for Business and Professionals**

Author: Wainman & Kydd, Chartered Accountants; and GreenLEAP
Publisher: The Canadian Institute of Chartered Accountants (CICA)
Date: November 1991

5. **Waste Minimization: Winning with the Environment**

Author: Doug Ferguson
Publisher: Canadian Manufacturers' Association
Date: February 1992

6. **Environmental Code of Practice**

Author: Canadian Petroleum Association
Publisher: Canadian Petroleum Association
Date: Revised Edition 1990

7. **Going Green Without Seeing Red**

Author: Canadian Restaurant & Foodservices Association
Publisher: Canadian Restaurant & Foodservices Association (CRFA)
Date: 1992

8. **How to be Green**

Author: John Button, Friends of the Earth
Publisher: Century Hutchinson Ltd.
Date: 1989

9. **Towards Proactive Environmental Management**

Author: Allan C. Howatson
Publisher: Conference Board of Canada
Date: 1990

10. **Your Business and the Environment; A D-I-Y Review for your Companies**

Authors: Geoff Lane, Andrew Shortis, Elaine Sullivan, et al.
Publisher: Coopers & Lybrand Deloitte/Business in the Environment (England)
Date: 1990

11. **D-I-Y Program for Small Business**

Author: Coopers & Lybrand
Publisher: Unpublished
Date: Prototype 1992

12. **Save Our Planet: 750 Everyday Ways You Can Help Clean Up the Earth**

Author: Diane MacEachern
Publisher: Dell Publishing
Date: 1990

13. **50 Simple Things Your Business Can Do to Save the Earth**

Author: The Earth Works Group
Publisher: Earth Works Press
Date: 1991

14. **Commercial Waste Reduction and Recycling Program**

Author: City of Edmonton
Publisher: City of Edmonton
Date: 1991

15. **What We Can Do for Our Environment**

Author: Communications Directorate for Environment Canada
Publisher: Environment Canada

Date: January 1989

16. **Pollution Prevention for the Great Lakes: Tips for Small Quantity Hazardous Waste Generators**

Author: LURA Group
Publisher: Environment Canada - Ontario Region
Date: September 1991

17. **Household Ecoteam Workbook**

Author: David Gershon, Robert Gilman
Publisher: Global Action Plan for the Earth (Canada)
Date: 1990

18. **An Environmental Self-Assessment Program: A Corporate Self-Assessment on Environmental Performance**

Author: Deloitte & Touche
Publisher: Global Environmental Management Initiative (GEMI), Deloitte & Touche
Date: Spring 1992

19. **Greening the Hill**

Author: Government of Canada
Publisher: Government of Canada
Date: June 1990

20. **Waste Minimization Manual**

Editor: Arthur H. Purcell
Publisher: Government Institutes, Inc.
Date: September 1990

21. **Workplace Guide: Practical Action for the Environment**

Editors: Michael Bloomfield (Executive Director), Louise Ward-Whare (Project Coordinator)
Publisher: Harmony Foundation (Canada)
Date: 1991

22. **Business Strategy for Sustainable Development: Leadership and Accountability for the 90's**

Author: Deloitte & Touche/IISD
Publisher: International Institute for Sustainable Development (IISD) Canada
Date: 1992

23. **Environment and the World of Work**

Author: International Labour Organization
Publisher: International Labour Office
Date: 1990

24. **Environment, Employment and Development**

Editor: A.S. Bhala, International Labour Organization
Publisher: International Labour Office
Date: 1992

25. **Caring for the Earth: A Strategy for Sustainable Living**

Editor: Robert Preston-Allen
Publisher: The World Conservation Union (UCN), United Nations Environment Program (UNEP), World Wide Fund for Nature (WWF)
Date: October 1991

26. **Friends of the Earth Handbook**

Editor: Jonathon Porritt
Publisher: MacDonald & Company
Date: 1987

27. **Guide for Environmental Practice**

Author: The Mining Association of Canada
Publisher: The Mining Association of Canada
Date: November 1990

28. **Sustainable Development: A Manager's Handbook**

Authors: David W. Conklin, Richard C. Hodgson, Eileen D. Watson
Publisher: National Round Table on the Environment and the Economy (NRTEE)
Date: 1991

29. **Decision Making Practices for Sustainable Development**

Author: National Round Table on the Environment and the Economy
Publisher: NRTEE (Canada)
Date: 1991

Title: Waste Reduction Action Plan; Part I
Industrial/Commercial/Institutional Solid Waste
Assessment Guide

Author: Association of Municipal Recycling Coordinators (AMRC), I/C/I
Subcommittee

Publisher: Association of Municipal Recycling Coordinators (Canada)

Date: 1991

Format: Workbook/Guide (27 pages)

Distribution: Through the Association

Focus: Solid waste

Structure: Issue specific

Content:

This is a small volume which guides the participant through a step-by-step assessment of the waste produced by their organization. Once this is done, the participant would proceed to the next volume, *Developing and Implementing a Waste Reduction Action Plan* to complete the process.

The steps in conducting the waste assessment are:

1. Company identification (basic information)
2. Materials currently being recycled
3. Current waste disposal methods and volume
4. Current composition of the non-recycled waste

Appendices: Glossary; Density conversions and standard weights; Sources of information; Blank forms for participant's use.

Themes: Introduction to the book points out importance of sustainable development, the costs of waste, and the increasing activities by the three levels of government to regulate waste production. Emphasis is on recycling and recyclable wastes.

This book is the first of two parts.

Related Products:

Companion text: *Waste Reduction Action Plan (I/C/I) Part II; Developing and Implementing a Waste Reduction Action Plan*

Title: Achieving Environmental Excellence: A Handbook for Canadian Business

Author: Peat Marwick Stevenson and Kellogg

Publisher: Canadian Chamber of Commerce (Focus 200 Program)

Date: September, 1990.

Format: Workbook/Guide (34 pages)

Distribution: Through the Chamber of Commerce

Focus: Generic (executive/business owner level)

Structure: EMS style

Content:

This book introduces and promotes the concept of an environmental plan for Canadian business.

After a brief introduction, the book gives six short "case studies" of Canadian companies that have been proactive on environmental issues. It then outlines a ten-step program for developing an environmental strategy:

1. Develop an environmental policy (beginning with goals and objectives)
2. Appoint an environmental champion and supporting team
3. Conduct an environmental performance review
4. Prepare an environmental action plan
5. Train and motivate staff
6. Allocate sufficient funds
7. Conduct ongoing market research
8. Communicate your endeavors
9. Adopt a spirit of cooperation between interest groups
10. Take a long-term view.

The text concludes with a list of 7 common pitfalls to avoid.

Appendices: Environmental checklist (an 8-point, 3 1/2 page guide to evaluating a company's current environmental performance); Environment-related contacts (organizations, gov't departments and publications)

Themes: Openness to change, honesty about progress made.

see *A Small Business Guide to Environmental Management*

Title: A Small Business Guide to Environmental Management

Author: Peat Marwick Stevenson and Kellogg

Publisher: Canadian Chamber of Commerce (Focus 2000 Program)

Date: 1991

Format: Workbook/Guide (75 pages)

Distribution: Through the Chamber of Commerce

Focus: Generic

Structure: EMS style

Content:

Intended as specific action guide to continue the process begun by *Achieving Environmental Excellence*. (The earlier document focused on the business opportunities resulting from changing consumer attitudes toward the environment.) The workbook is based on seven step process:

1. Develop an environmental policy
2. Appoint an Environmental Coordinator and supporting team
3. Conduct an environmental audit
4. Identify environmental opportunities
5. Prepare an environmental action plan
6. Train and motivate your staff
7. Communicate your endeavors

With the exception of two introductory and one concluding chapter, the workbook is organized in chapters based on each of the seven steps. Within each chapter, there is a general introductory section followed by a closer look at the elements of the particular step, and suggestions to guide the participant through the process.

Appendices: Waste flow diagram, Environmental audit checklist, List of environment-related government programs; List of non-profit organizations concerned with business and the environment in Canada; Bibliography (23 items)

Themes: This workbook emphasizes a pro-active approach, and promotes the competitive, strategic, and long-term financial advantages of implementing an environmental management system. It can be used on its own, or in conjunction with a workshop (see below).

Related products:

Seminar: The book recommends that operators participate in the "Environmental Management" workshop which is based on the content of the current document.

Companion texts: The book complements, but does not require *Achieving Environmental Excellence* (also in this series of reviews)

Title: The Environmental Manual for Business and Professionals

Author: Wainman & Kydd, Chartered Accountants; and GreenLEAP (Dwight Wainman, Editor)

Publisher: The Canadian Institute of Chartered Accountants (CICA)

Date: November, 1991

Format: Workbook (Loose leaf binder, approx. 270 pages)

Distribution: Through CICA

Focus: Generic

Structure: EMS style

Content:

The Environmental Manual is a comprehensive reference source on environmental issues affecting business and professional activities. The Manual introduces the reader to the basics of environmentalism, and then focuses on such topics as: environmental issues and financial reporting; environmental consulting and law; Canadian environmental law; government grants; taxation; and environmental management systems. It is in a loose leaf format, with quarterly updates.

The chapter, Environmental Management Systems, is aimed at corporate accountants and other financial professionals. It begins with suggestions as to who in the organization should be involved in the EMS. These individuals would cooperate in developing an Environmental Policy Statement. The Statement would take into account the overall vision of the organization, its mission and core values, and would also consider the needs of stakeholders, outside groups, and employees. Also included would be guidelines for products and services, operating efficiency, and compliance with legislation.

The chapter moves on to environmental systems and controls, which are the functioning components of the EMS, and examines some of the tools which may be useful for monitoring and improving environmental performance.

The Manual also has a section titled "Environmental Programs and Checklists", which examines, among other issues, the current management programs and systems in an organization. This checklist, in an interactive, workbook style, asks about management systems in the areas of: general organization; policies; education/training; emergency measures; employee matters; business transactions; public relations; marketing; insurance; environmental performance; computerized systems; future/planning; and documents.

Appendices: Three appendices to the EMS chapter list relevant software.

Themes: EMS system, but looked at from an accountant's viewpoint.

Title: Waste Minimization: Winning With The Environment

Author: Doug Ferguson

Publisher: Canadian Manufacturers' Association

Date: February, 1992

Format: Booklet (16 pages)

Distribution: Through the Association

Focus: Reducing waste and cost

Structure: Issue and sector specific

Content:

This workbook follows a step by step process on how businesses can implement a waste minimization program within their organization. It also briefly mentions how these organizations can evaluate their progress. This workbook offers a detailed step by step process on how to develop an effective Waste Minimization plan. The booklet is divided into the following sections:

1. Building a Solid Foundation for Your Waste Minimization Program

- Policy
- Defining Waste
- Management/employee "buy-in"
- The lead Players
- Setting Goals

2. Putting Your Plan Together

- Assessment
- Priorities
- Options
- Economics
- Evaluation

3. Working with Suppliers

4. Legal Considerations

Appendices: For further Help and Information

Theme: Waste management can be profitable.

Title: Environmental Code of Practice

Author: Canadian Petroleum Association
Publisher: Canadian Petroleum Association
Date: Revised Edition 1990

Format: Brochure/Pamphlet (17 pages, backed w/ Fr. vers.)
Distribution: Through CPA
Focus: Guiding Principles
Structure: Industry specific

Content:

This pamphlet outlines the set of six guiding principles which have been recommended to the members of the sponsoring associations. Each principle is stated, and then given a brief (one-page) explanation.

1. Planning
2. Consultation
3. Compliance
4. Corrective Action
5. Emergency Response
6. Research

Related products:

Companion text: The CPA also publishes an associated document called the "Environmental Operating Guidelines". The guidelines "provide considerable information on the regulatory framework under which industry operates, and include standard environmentally accepted procedures for constructing and operating petroleum facilities."

Notes: Adopted in November, 1989 by Independent Petroleum Association of Canada. Both associations are now co-sponsors. CPA also offers a series of environmental publications: Overview; Sour Gas; Land Reclamation; Water; Waste Management; Air Quality; Bibliography of Publications (lists papers and reports on petroleum and environmental research by CPA committees).

Title: Going Green Without Seeing Red
Author: Canadian Restaurant & Foodservices Association
Publisher: Canadian Restaurant & Foodservices Association (CRFA)
Date: 1992

Format: Workguide (42 pages)
Distribution: Through the Association
Focus: Waste in the Food Service Industry
Structure: Industry Specific

Content:

This guide is specifically concerned with the food industry. It is divided into 2 main parts:

1. Overview of Environmental Concerns and their impact on the food services industry
2. Suggestions on how to measure waste, through waste audits and how to eliminate waste

In the waste management plan there is a waste audit of non-food and food waste; suggestions for reducing packaging, and food waste; and suggestions on how to get people involved; how to deal with outside services, and government programs. It is mostly information. There are no worksheets or detailed how-to's; although there are several 'quick tips'.

Appendices: List of contacts; glossary of terms

Title: How to be Green

Author: John Button, Friends of the Earth

Publisher: Century Hutchinson Ltd.

Date: 1989

Format: Textbook/guide (233 pages)

Distribution: Trade Press

Focus: Home and office

Structure: Issue specific

Content:

This book is geared towards making a people more environmentally aware, and focuses on different areas that are affected through the greening process. Each section is divided into four subsections:

1. The facts
2. What needs to change
3. What you can do
4. Who Benefits

There are thirteen major areas covered and each of these major areas deals very practically with connected concerns. The major areas covered are:

1. Home conservation
2. Spring-Greening
3. About the House
4. Gardening
5. Food
6. Packing up
7. Countryside
8. Children
9. Health
10. Clothes
11. Transport
12. Work and Money
13. Press for Action

Appendices: Organizations and suppliers; Eco-fax; A basic green library; About Friends of the Earth.

Title: Towards Proactive Environmental Management

Author: Allan C. Howatson

Publisher: Conference Board of Canada

Date: 1990

Format: Report

Distribution: Through the Conference Board

Focus: Environmental Policies

Structure: Generic EMS Style

Content:

This report describes the environmental policies of a selected group of companies (e.g., CPA, Noranda, Dow Chemical).

These companies describe how their firms have become environmentally conscious, and how they have incorporated environmental factors into their everyday business decisions. However, no distinct EMS has been set out.

The purpose of this report is to highlight common/innovative environmental management practices of a number of larger Canadian corporations, in order to familiarize other sectors of Canadian society with practical ways in which business can strengthen its management of environmental issues.

The material is set out to consider several key activities:

1. Top Management Support
2. Management Systems
3. Integrated Planning
4. Stakeholder Consultation

Themes: Policy and Planning

Appendices: Companies and Individuals Interviewed; Examples of Environmental Policy; Further Reading

Title: Your Business and the Environment; A D-I-Y Review for Companies

Author: Geoff Lane, Andrew Shortis, Elaine Sullivan, et al.

Publisher: Coopers & Lybrand Deloitte UK

Date: 1990

Format: Workbook/guide

Distribution: Coopers & Lybrand UK

Focus: Generic

Structure: EMS style

Content:

The purpose of this book is to guide the participant through an environmental review of their organization. It makes clear that this review is not an environmental audit, but can provide a framework for planning an EMS.

The book lays out a ten point environmental plan, which is outlined in more detail in this book's sister publication (see below). The steps in the plan are as follows:

1. Look at issues, existing regulations, standards (what can be achieved?), and examples of others' programs
2. Develop a framework environmental policy
3. Carry out a total assessment of the current environmental position and performance of your company.
4. Firm up on specific policies. Develop plans, set targets.
5. Communicate the policies and plans internally
6. Allocate environmental responsibilities at all levels
7. Educate employees; encourage participation
8. Integrate environmental management and considerations into normal business processes
9. Communicate intentions, actions, and ideas to outside world
10. Continuously monitor and review policies, plans and performance in the light of new information on scientific advances, legislation and industrial activity.

This book is intended to help the participant carry out points 1 and 3. It does this through the use of two "trails" - one dealing with process and the other with issues. Within the trails, there is a second parallel process - the left side of the page gives the step to be performed, and the right side lists considerations related to that step.

Appendices: Three appendices provide guidance in drafting an environmental policy. The others are: Using Questionnaires; Understanding Key Issues (58 pages); Structuring the Report; a bibliography (25 items); and Contacts.

Related products:

Companion texts: *Your Business and the Environment - An Executive Guide*

Title: D-I-Y Program for Small Business

Author: Coopers & Lybrand

Publisher: Unpublished

Date: Prototype, 1992

Format: Workbook/Guide (loose-leaf binder)

Focus: Generic (small and medium-sized businesses)

Structure: EMS style

Content:

This is a prototype D-I-Y manual for small and medium-sized business. Most of the chapters are in outline form. Currently, the method is to give general guidance in each chapter, and to complement this with a series of appendices which either give more information; provide a planning chart for that particular step; or provide more specific questions to be used when executing that step.

The manual follows a five-step approach for building an environmental program:

1. Understanding - Define objectives and build a team; produce a project plan or outline; gather information (on environmental policies, external forces, solid waste production, and packaging); evaluate findings.
2. Setting Goals - Set out overall objectives; establish priorities; set specific targets.
3. Developing Strategy - Pick priorities; examine entire organization for possible solutions; build partnerships (with suppliers, distributors, customers, other industries, etc.); fine-tune plans.
4. Implementing - Get commitment from key individuals; communicate plans; train employees; agree on resources needed and actions to be taken; take steps to encourage participation.
5. Monitoring/Sustaining - Monitor progress regularly; celebrate successes; be willing to change course if necessary; foster continuous improvement; perform periodic environmental audits.

Appendices: Appendices 1-7 complement chapters 1-5 as described above. Other appendices provide: bibliography; a list of contact organizations; and a glossary.

Themes: Strong planning component

Title: Save Our Planet: 750 Everyday Ways You Can Help Clean Up the Earth

Author: Diane MacEachern

Publisher: Dell Publishing

Date: 1990

Format: Textbook/guide (210 pages)

Distribution: Trade Press

Focus: Individual action

Structure: Issues specific

Content:

This is similar the the guide published by the Friends of the Earth. After discussing the general need for change in the introduction, nine chapters are devoted to specific issues. Each chapter includes a general discussion of the issues, helpful tips, tables and easy to understand facts, set-apart pieces on 'bright ideas', a section on 'sources' indicating where the information comes from and question and answer self-assessments. The nine chapters deal with :

1. In your home
2. In your garden
3. In the garage
4. At the Supermarket
5. At School
6. At the Office
7. In your community
8. In your apartment
9. Vacations

Appendices: Resources; Organization Working to Save Our Planet.

Title: 50 Simple Things Your Business can do to Save the Earth

Author: The Earthworks Group

Publisher: Earthworks Press

Date: 1991

Format: Workguide (115 pages)

Distribution: Trade Press

Focus: Environmentally friendly offices

Structure: Issue specific

Content:

This book has been divided into 3 main sections:

1. Simple Things - Outlines simple ways of making your office more environmentally friendly (e.g., using mugs instead of using Styrofoam cups)
2. It Takes Some Effort - Outlines more indepth measures that should be taken if a company wishes to incorporate their environmental efforts into their everyday business activities. (Eg. setting up a recycling program)
3. For the Committed - Outlines methods that express a companies true commitment to the environment. (e.g., making environmental policies, reusing water)

Although this book offers various levels of commitment to the environment, no concrete EMS system has been established and implemented. This books main focus is to encourage businesses to incorporate environmentally sound thinking into their everyday business actions.

Title: Commercial Waste Reduction and Recycling Program.

Author: City of Edmonton

Publisher: City of Edmonton

Date: 1991

Format: Workbook/guide and information package

Distribution: City of Edmonton

Focus: Waste reduction

Structure: Issue specific

Content:

This information package is designed to guide the participant/reader through a waste reduction audit and the development of a waste reduction plan.

The focus of the package is the waste reduction audit. Once this has been performed, various options would be generated. These would be analyses for cost, and a final program developed. The program would be of the reduce/reuse/recycle type.

The basic steps in the audit are:

1. Estimate material quantities
2. Survey Buildings for Storage Space
3. Determine Cost Handling Method
4. Conduct Cost Benefit Analysis
5. Liaison between Recyclers of Businesses
6. Develop Implementation Strategies
7. Program Monitoring

The audit looks at cardboard, plastics, organic waste, paper, metals and glass; and also considers regulations and landfill questions.

Themes: Functional guide, based on waste reduction audit

Title: What We Can Do For Our Environment

Author: Communications Directorate of Environment Canada

Publisher: Environment Canada

Date: January, 1989

Format: Brochure/Pamphlet (49 pages)

Distribution: Through Environment Canada

Focus: Individual action

Structure: Issue specific

Content:

This pamphlet is a "simple to use guide... offering hundreds of tips and suggestions on environmentally friendly habits for individual Canadians to practise every day, everywhere." The emphasis is on daily actions, rather than long-term plans. The section, "At Work" is three pages of general suggestions, with special sections for indoor workers, outdoor workers, farmers, and fishermen.

Appendix: Where To Get Help

Themes: Daily activities can make a difference.

Title: Pollution Prevention for the Great Lakes: Tips for Small Quantity Hazardous Waste Generators

Author: LURA Group

Publisher: Environment Canada - Ontario Region

Date: September, 1991

Format: Workbook/guide

Distribution: Environment Canada

Focus: Generic (for industries around the Great Lakes)

Structure: Issue specific

Content:

This is a very simple guide to waste management for small Canadian businesses and industries on the Great Lakes.

The guide explains what toxic waste is, where it comes from, and the benefits of minimizing it. The solutions it presents are: Material substitution; reduction; reuse; and recycling. It also provides a brief guide to developing a hazardous waste management action plan. The prescribed steps are:

1. Conduct an internal waste audit of your business.
2. Contact a licensed hazardous waste collection company for safe collection and disposal information.
3. Contact your local trade or business association for information and helpful hints.
4. Contact the Canadian Waste Exchange for help on finding another person or business that could reuse your waste.

Themes: Functional - no management systems

Title: Household Ecoteam Workbook

Author: David Gershon, Robert Gilman

Publisher: Global Action Plan for the Earth (Canada)

Date: 1990

Format: Workbook (179 pages)

Distribution: Trade Press

Focus: Group/Community action

Structure: Issues specific

Content:

Outlines a 6 month program to help bring your household into environmental balance and make an impact on global environmental goals through working in six actions areas. Everyone who uses the guide is asked to register with gap so that information can be gathered, assessed and shared. It is set out so that each chapter gives guidance on what to do that month. It includes background information, hints and suggestions and checklists for record keeping. It also stresses follow-up and continuous improvement. The six steps are:

1. Reducing your waste
2. Improving Home Water efficiency
3. Improving Home Energy Efficiency
4. Improving Transportation Efficiency
5. Being an Eco-wise Consumer, and:
6. Empowering others

Appendices: The Big Picture; Bibliography; End of Program Report.

Title: An Environmental Self-Assessment Program: A Corporate Self-Assessment on Environmental Performance

Author: Deloitte & Touche

Publisher: Global Environmental Management Initiative (GEMI), Deloitte & Touche

Date: Spring 1992

Format: Workguide prototype (19 pages)

Distribution: Deloitte & Touche/GEMI

Focus: Environmental assessment

Structure: EMS style

Content:

This workguide describes the Environmental Self-Assessment Program (ESAP), a program developed to measure and improve the environmental management performance over time, with a focus on corporate level policy, systems, and performance measurement programs.

This evaluation system is based on the sixteen principles of the ICC Business Charter. Each Principle is divided into a number of elements--such as scope, management involvement, resources, communications, implementation and accountability; and each element is rated according achieved performance. There are four levels of performance, from the basic regulatory compliance to continuous improvement. Each element is also assigned a weighting by importance--either A, B, or C.

The ESAP is set out as a worksheet that can be filled in. Each ranking must also be supported by comments that s for the assessment.

Title: Greening the Hill

Author: Government of Canada

Publisher: Government of Canada

Date: June 1990

Format: Pamphlet (24 pages)

Distribution: Through the Government

Focus: Government workplace programs

Structure: Issue specific

Content:

This is a small promotional pamphlet that outlines the Government's activities in greening up the House of Commons. Their objective is accomplished by implementing a plan that calls for:

1. Eliminating environmentally harmful policies, practices and materials and replacing them with environmentally appropriate alternatives
2. Making everyone at Parliament Hill more aware of the environment and ways to protect it.
3. Eliminating the use of hazardous substances where reasonable, and taking every precaution with those substances necessary to House operations.

There are nine sections devoted to specific areas or issues to support this plan.

1. Protecting the grounds
2. Reducing and reusing paper products
3. Recycling paper products
4. Cutting back on food related waste
5. Conserving energy and water
6. Converting the fleet
7. Greening building operations and maintenance
8. Buying greener products
9. Key organizers and participants

After a short introduction each section details programs already or about to be instituted by the government that should be followed, as well as special notes on CFC's, PCB's and Asbestos.

Appendix: A plea from John Fraser, Speaker of the House

Title: Waste Minimization Manual

Editor: Arthur H. Purcell
Publisher: Government Institutes, Inc. (Rockville, Maryland)
Date: September, 1990

Format: Textbook
Distribution: Trade Press
Focus: Generic/business (focus on waste management)
Structure: Issue specific

Content:

This book consists of a series of articles, all dealing with the subject of waste. There is a logical progression to the series, starting with the economic and legal/regulatory incentives for waste minimization; how to conduct a waste minimization audit, implementing a waste minimization program, then more specific waste issues, and then a series of case studies.

The article, "How to Conduct Your Waste Minimization Audit" (page 61) has, in addition to its stated topic, some discussion of the waste minimization program of which the audit would be a part. According to the article, an industrial waste minimization program would include the following components: Planning, Auditing, Implementation, Communication. Within the planning component, the typical plan:

1. Opens with a statement of purpose or objectives (in many cases, from a senior corporate official.)
2. Contains strategy to insure proper "buy in" from production units and labour.
3. Contains extensive communications and feedback mechanisms
4. Has defined the extent to which outside services will be used.

The article, "Implementing a Waste Minimization Program" (page 71) is brief, and gives the steps to be followed in implementing technical solutions to waste problems: engineering feasibility study, treatment/treatability testing, pilot-scale testing, full scale implementation.

The book is very specifically concerned with waste minimization, and recognizes the importance of source reduction, in addition to end-of-pipe controls. While it discusses planning at every stage, it does not prescribe an overall environmental management system.

Themes: Very functional approach which doesn't highlight management systems.

Title: Workplace Guide: Practical Action for the Environment

Author: Michael Bloomfield (Executive Director), Louise Ward-Whare (Project Coordinator)

Publisher: Harmony Foundation (Canada)

Date: 1991

Format: Workbook/guide (170 pages)

Distribution: Harmony Foundation, NRTEE

Focus: Generic

Structure: EMS style

Content:

This is a comprehensive workbook and guide, to be used by people at any level of an organization.

The book lays out a series of steps in the establishment of an EMS. These are:

1. Launch a staff-awareness campaign.
2. Organize and conduct an environmental assessment
3. Strike an action plan
4. Implement the plan
5. Monitor the results

The execution of these steps is supported in two ways; through information, and through worksheets. The information is provided in a series of reviews of each of six important environmental issues faced by a business. These are: energy, hazardous materials, waste, water, transportation, and purchasing. For each of these topics, the guide first lists a number of actions that can be taken immediately to improve environmental performance. There is then a short introduction, a list of target areas and actions for the environmental plan, and some success stories related to the topic. Finally, there are print and organizational sources listed after each section.

The assessment worksheets and action planner are in a separate section (26 pages). The assessment sheets comprise a review of the organization's performance in each of the six areas mentioned above. The action planner is a chart which shows what tasks have been accomplished, what tasks should be accomplished, and the time and personnel elements related to each of those tasks.

Appendices: Sources and references at the end of each chapter.

Themes: Action can begin at any level in the organization, and some things can be done even before the environmental plan is established.

Title: Business Strategy for Sustainable Development: Leadership and Accountability for the 90's.

Author: Deloitte & Touche/ IISD

Publisher: International Institute for Sustainable Development (Canada)

Date: 1992

Format: Textbook (spiral bound, 116 pages)

Distribution: Through the Institute

Focus: Generic (emphasis on large, public corporations)

Structure: EMS style

Content:

This book discusses sustainable development in relation to business strategy, planning and practices. The first 2/3 of the book is a general guide to the development and implementation of an EMS. The balance of the book is an examination of the issues surrounding the monitoring and reporting of environmental performance.

In discussing sustainable development, the book follows a logical progression: It begins with an overview of the business perspective on sustainable development. It then covers the steps needed for the incorporation of sustainable development into a business. The steps can be summarized as follows:

1. Develop overall strategy for the organization
2. Perform stakeholder analysis to see who is directly or indirectly affected by the enterprise's operations - and their needs.
3. Set sustainable development policies and objectives
4. Design and execute an implementation plan
5. Foster internal corporate support for the plan
6. Measure, monitor, and communicate progress
7. (Section ends with a 1-page CHECKLIST on starting an EMS)

The book takes a wide view of the topic of sustainable development; even in the section dealing with the development of the EMS, the text places each step in a philosophical (and sometimes historical) context and gives examples of how other companies have performed that step. This shift from general to specific places each step in a strong context, but it does not provide the directness found in a workbook-style document.

Appendices: The current state of affairs - profile of what is being reported now; Survey of corporate reporting on sustainable development - country profiles; A sample sustainable development report - Cleanco International; A case study - TransAlta Utilities.

Themes: Sustainable development must become a fact of corporate life. Emphasis on monitoring, evaluation, communication,

Title: Environment and the World of Work

Author: International Labour Organization

Publisher: International Labour Office

Date: 1990

Format: Report (106 pages)

Distribution: Through ILO

Focus: Part played by workers

Structure: EMS style

Content:

This book places the activities and inputs of labour into the context of development and the environment. After providing a general over view of the earth, air and water issues facing the world, there is focussed discussion of policy issues--including its effects on society, trade, north-south and east-west issues and competition.

These issues are then all related to their potential to affect workers. Issues considered included, employment, training and industrial relations. It ends with a discussion of the role to be played by governments and labour organizations.

The report argues that the main difficulties in dealing with the environment are not technical but political, economic and social. It aims to find a way in which all stakeholders can participate.

Appendices: ILO contribution to environmentally sound & sustainable development, Contribution of ILO concerning the protection & enhancement of the environment related to work.

Title: Environment, Employment and Development

Editor: A.S. Bhalla

Publisher: International Labour Office

Date: 1992

Format: Report (177 pages)

Distribution: Through the ILO

Focus: Environmental policies

Structure: Issues specific

Content:

This report focuses on economic and environmental issues in both industrialized and developing countries, and describes indepth how sustainable development will affect them.

The report also describes in detail how environmental policies should be designed so that differences that exist between high development countries and low development countries are incorporated :

Related Products: Environmental Management training - 5 Volumes: Series of training materials developed to support Environmental Management training .

Title: Caring for the Earth: A Strategy for Sustainable Living

Author/Editor: Robert Preston-Allen

Publisher: The World Conservation Union (IUCN), United Nations Environment Program (UNEP), World Wide Fund for Nature (WWF)

Date: October, 1991

Format: Workplace Guide

Distribution: Through the Associations

Focus: Generic

Structure: EMS style

Content:

To be used by those who shape policy and make decisions that affect the course of development and condition of our environment. This is a generic guide which does not focus specifically in any one area; the Business/Industry section however provides more specific steps to the commitment to sustainability:

1. develop and publish a corporate environmental policy
2. prepare an action program
3. make a member of the company's board responsible for environmental policy
4. delegate responsibility to individual line managers for ensuring processes
5. offer incentives for meeting health, safety & environmental targets with pay/promotions
6. introduce environmental education programs/training for managers.
7. review progress with the environmental action plan regularly
8. increase R&D, in order to improve the company's ability to prevent pollution, reduce waste etc.
9. monitor emissions & environmental quality to check that the company's controls are effective
10. institute environmental & safety audits
11. ensure high standards are maintained, remove environmentally unsafe technology
12. provide lower income countries with information on measures to protect health & ensure sustain.
13. provide environmental training programs to lower income countries

Appendices: Statistics, Indicators of sustainability, Estimated costs of implementation of strategy, Strategies for sustainability.

Title: Friends of the Earth Handbook

Editor: Jonathon Porritt

Publisher: MacDonald & Company

Date: 1987

Format: Textbook

Distribution: Trade Press

Focus: Individual action

Structure: Issue specific

Content:

The twelve chapters of this book are aimed at effecting cultural change. It deals with the major earth air and water issues by painting the large picture and emphasizing the need to change. The middle chapters deal with more practical ways in which individuals can respond to the issues. The final chapters deal with helping the spread the word and educate others.

Appendix: Campaigning: How to create community groundswell. Bibliography at the end of each chapter.

Title: Guide For Environmental Practice

Author: The Mining Association of Canada

Publisher: The Mining Association of Canada

Date: November, 1990

Format: Brochure/Pamphlet (13 pages, backed with French version)

Distribution: Through the Mining Association of Canada

Focus: Policy

Structure: Industry specific

Content:

This brochure is a statement of and expansion on the Mining Association of Canada's Environmental Policy. This policy is based on six principles, covering: compliance with legislation; self-regulation in the absence of legislation; self-monitoring to ensure compliance; research; contribution to public policy; and communications with governments, employees, and the public.

In its introduction, the brochure states that member companies are committed to developing environmental management skills to a level comparable with those they use in economic management. Other than that, specific management techniques are not mentioned.

Themes: Environmental principles to guide members' activities.

Title: Sustainable Development: A Manager's Handbook

Authors: David W. Conklin, Richard C. Hodgson, Eileen D. Watson

Publisher: National Round Table on the Environment and the Economy (NRTEE)

Date: 1991

Format: Workbook/Guide (137 pages)

Distribution: Through NRTEE

Focus: Generic

Structure: EMS style and checklists

Content:

This book is intended to be an introduction and guide to sustainable development for managers. Part A points out the legal, ethical, regulatory, and competitive reasons for adopting sustainable development.

Part B is a do-it-yourself environmental audit, consisting of 20 general questions (example: "In your corporate decisions, do you place heavy weight upon future profits and future tougher laws as opposed to current profits and current laws?")

Part C is a guide to improving environmental performance. The first chapter of this part, "Developing a Management Strategy" is a series of 3 exercises intended to be completed by the manager. This person would solicit input from higher levels - upper executives and Board members - but the underlying philosophy is that successful change must be based on a solid foundation of goal definition, measurement, feedback, and reinforcement; which can then work its way up into goals, strategies, and visions.

The exercises in this chapter ask questions about the company's strategic, tactical and implementational responses to sustainable development. The answers they elicit are intended to coalesce into a program of action (example: What input and output measurements are you taking to monitor your organization's performance in Sustainable Development? What additional measurements would be helpful and feasible?)

The next chapter discusses the importance of employee support for the sustainable development program, and then presents two exercises which help the participant to look at what is being done in this area.

The balance of the book provides a listing of resources (associations and governments), a selection of 12 Canadian success stories, and a conclusion.

Themes: Change need not come exclusively from upper levels.

Notes: Introduction suggests that participants send NRTEE a disk with their answers to the exercises in Parts B and C for possible incorporation into later editions.

Title: Decision Making Practices for Sustainable Development

Author: National Round Table on the Environment and the Economy (NRTEE)

Publisher: NRTEE (Canada)

Date: 1991

Format: Workbook/guide (133 pages)

Distribution: Through NRTEE

Focus: Generic

Structure: EMS style (based on "code of practice")

Content:

The focus in this book is on sustainable development, and ways to incorporate it into different sectors of society (the introduction specifies: business associations, corporate sector, federal government, labour, municipal governments, and non-governmental organizations.)

The first half of the book discusses the reasons for an organization to change; successful management strategies; management tools; barriers to success; and the kind of changes in decision making which are necessary for sustainable development. Each of these topics is examined from the point of view of each of the societal sectors (business associations, corporate sector, etc.) being addressed. For example, the successful management strategies for implementing sustainable development in a corporation would be different from those used in a labour organization.

There is no prescription in this book for an Environmental Management System as such, but the chapters on Successful Management Strategies and on management tools have some suggestions for businesses incorporating sustainable development into their operations. The suggestions would be useful to any business, no matter what their current environmental plans; but would complement an EMS quite well.

The second half of this book is a workbook-type guide to developing a Code of Practice for businesses and for trade and industry associations. There are 23 topics covered in this section, including: business aims and strategies; staff education and training; information sharing, and purchasing practices. Again, the product of the exercise is not an EMS, but the information gathered and the decisions made would be useful in the planning stages of an EMS.

Themes: A Code of Practice is highly useful in a sustainable development program.

Title: New York State Waste Reduction Guidance Manual

Author: The New York State Department of Environmental Conservation

Publisher: The New York State Department of Environmental Conservation

Date: March, 1989

Format: Workbook/guide (approx. 80 pages)

Distribution: New York State

Focus: Waste management for industries in New York State

Structure: Issue specific

Content:

This is a workbook-type guide to waste management. It has few EMS elements.

The book begins by pointing out the reasons behind a waste management program. It guides the participant through a waste reduction audit, and proceeds from there to an examination of waste reduction techniques - both general and industry-specific. The next step is a feasibility analysis, based on technical and economic feasibility. The last chapter (3 pages) discusses documentation of the research phase, staff and management motivation, implementation of the chosen course of action, and sustaining the program.

Appendices: New York Waste Reduction Activity Form and Instructions; Additional Resources (agencies, associations, government departments, etc.); References (120 items); Glossary; and Applicable Rules and Regulations.

Themes: Functional guide on a specific issue

Title: Industrial, Commercial, and Institutional Recycling in Ontario: Operator's Handbook

Author: Resource Integration Systems Ltd.

Publisher: Ontario Multi-Material Recycling Incorporated

Date: 1990

Format: Workbook/Guide (44 pages)

Distribution: By the publisher

Focus: Recycling for profit

Structure: Industry specific

Content:

This is a guide for recycling firms seeking to expand from residential recycling into ICI (industrial, commercial, institutional) recycling. As such, the goals and objectives are already assumed - to get more sources of recyclable materials and to establish a sufficient market for the collected material. Any planning/audit suggestions are given in the context of providing advice to client firms.

The D-I-Y information in this guide is found in its advice on conducting site visits. It includes a sample Waste Auditing Questionnaire with a form for the data collected. It also includes the program design procedure (1: determine system for moving recyclables with the facility; 2: determine system for the storage of recyclables; and so on).

Appendices: Locating a market for your secondary materials; Calculations and how to use them; Container suppliers and manufacturers storage/container options.

Themes: Functional guide; very little on management systems level.

Title: Industrial Waste Audit and Reduction Manual; a Practical Guide to Conducting an In-plant Survey for Waste Reduction

Author: CANVIRO Consultants
Publisher: Ontario Waste Management Corporation (OWMC)
Date: 2nd Edition, July, 1989

Format: Workbook/guide (spiral bound, 91 pages)
Distribution: Through OWMC
Focus: Waste management
Structure: Issue specific

Content:

This book is intended to guide the reader through a waste audit at their business or institution, and then help them to establish a waste reduction program.

The prescribed steps are as followed:

1. Understand the processes in the plant
2. Define process inputs
3. Define process outputs
4. Conduct material balance study
5. Identify waste reduction alternatives
6. Cost/benefit analysis and implementation of action plan

This section (the six steps) takes up about 1/3 of the book.

The book also provides case studies, and a section on resources and information (organizations and publications)

Themes: Functional approach. No real management component/context.

Title: Profit from Pollution Prevention; A Guide to Waste Reduction and Recycling in Canada

Author: Glenn Munroe, William Bradley, Fay Neuber

Publisher: Pollution Probe Foundation (Canada)

Date: 2nd Edition Revised, 1990

Format: Workbook/guide (105 pages)

Distribution: Through Pollution Probe

Focus: Waste management

Structure: Issue specific

Content:

This book applies EMS-type principles to the specific topic of waste management. It is in two parts: the first gives guidance in the establishment of a waste reduction program; and the second lists and describes sources of information and support (government, commercial, associations, etc.) for a company undergoing this process.

In part 1, the recommended tasks are divided between two teams; the Waste Reduction Task Force and the Waste Reduction Assessment Team (which is created by and serves the Task Force). The steps given for the Waste Reduction Task Force are:

1. Planning and organization - Develop policy and set goals; establish priorities.
2. Assessment - Select assessment team; review report from team; consider factors affecting implementation; decide priorities and select projects
3. Implementation - Develop implementation guidelines; prepare schedule; develop employee education and participation programs
4. Monitoring and evaluation - Evaluate specific projects based on reports from assessment team; monitor on-going progress towards program goals

The steps given for the Waste Reduction Assessment Team are:

1. Assessment of current situation - Perform a waste audit; identify possible project options; prepare assessment report for task force (coincides with step 2 above)
2. Evaluation of projects - Evaluate on-going performance of new system with respect to projected data. (coincides with step 4 above)

Appendices: Analyzing costs; Bibliography (43 items)

Themes: Strong management systems focus to a program which promises cost savings, while at the same time preventing the potential legal/regulatory/commercial problems associated with waste issues.

Related products: Volume II (same title), discusses a wide variety of technologies for reducing wastes.

Notes: Good layout and interactive format

Title: The Office Guide to Waste Reduction and Recycling

Author: Recycling Council of Ontario

Publisher: Recycling Council of Ontario

Date: 1991

Format: Brochure/Pamphlet (32 pages)

Distribution: Through RCO

Focus: Office waste management

Structure: Issue specific

Content:

This is a basic guide to office waste management. It focuses on the developing good habits for people working with paper, and looks at the changes that can be made in their behavior. It is divided into four sections:

1. The Office Waste Problem
2. The Office Waste Solution
3. Office Waste Paper Recycling
4. Becoming 3 R Literate

The most complete section deals with setting up a recycling program in an office. This seven-step program includes:

1. What you should know before you begin
2. Choosing a coordinator
3. Determining your recycling potential
4. Designing a recovery system
5. Selecting a waste paper dealer
6. Discovering your program's true value
7. Generating enthusiasm and motivating participation

There is a waste audit record checklist and a simple form for calculating monetary gain derived from recycling efforts.

Themes: Functional guide to a single-issue program

Appendix: There is a list of all Provincial recycling councils.

Title: Green Lights: A Bright Investment in America's Future

Author: U.S. Environmental Protection Agency

Publisher: U.S. Environmental Protection Agency

Date: 1990

Format: Video

Distribution: Through EPA

Focus: Energy efficiency for lighting systems in business and industry

Structure: Issues specific

Content:

The purpose of the video is to promote the use of energy- efficient lighting in businesses and industries in the US, and to publicize the Environmental Protection Agency's "Green Lights" program. This government program offers technical support and publicity to companies wishing to change their lighting.

Themes: Energy-efficient lighting can save money and cut pollution, while improving the work environment as well.

Related Products: This is the first in a series of three videos. Part 2, *Details on Energy Efficient Lighting Technologies*; Part 3, *Details on the Memorandum of Understanding*.

